

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON DC 20330-5130

REPLY TO
ATTN OF: LEED

SUBJECT: Engineering Technical Letter (ETL) 90-1:
Built-Up Roof (BUR) Repair/Replacement Guide Specification

TO: SEE DISTRIBUTION LIST

1. Purpose: This letter provides a roofing guide specification (attachment 1) to use when specifying a built-up roofing membrane for a repair/replacement project. It supersedes ETL 87-8, Built-Up Roof Repair/Replacement Guide Specification. This ETL is authorized by AFR 8-7, Air Force Engineering Technical Letters (ETL).

2. Effective Date: Immediately.

3. Referenced Publications:

- a. AFR 91-36, Roof Management Program
- b. AFR 88-15, Air Force Design Manual - Criteria and Standards for Air Force Construction, Chapter 7
- c. AFM 91-31, Maintenance and Repair of Roofs

4. Description/Implementation:

a. Tailor and use this guide specification on all BUR reroofing projects in the CONUS. Oversea locations should use host country roofing design standards and systems as applicable.

b. This specification contains specific notes. Read each note and modify this standard specification as required to ensure it is technically correct and well coordinated with the drawings. Do not include specifier notes in the contract documents. Refer to attachment 4 in the Guide Specification for specific guidance on how to prepare a complete reroof contract package.

c. Air Force policy promotes conversion of low-slope roofs to steep roof systems during the reroofing process when aesthetically pleasing and economically feasible. Design reroofing of dead-flat roofs which pond water to provide a minimum slope of 1/4 inch per foot.

5. The action officer for this ETL is Mr. Julian Ius, P. E., HQ AFESC/DEMM, AUTOVON 523-6236.

FOR THE CHIEF OF STAFF

JOHN A GILLIS, Col, USAF
Dep Ch, Installation Development Div
Directorate of Engineering and
Services

3 Atch

- 1. Distribution List
- 2. Guide Specification
- 3. ETL Index

ETL DISTRIBUTION LIST

HQ AAC/DEE/DEM/DEP (3)
ELMENDORF AFB, AK 99506-5001

HQ AFCC/DEE/DEM/DEP (3)
SCOTT AFB, IL 62225-6001

HQ AFLC/DEE/DEM/DEP (3)
WRIGHT-PATTERSON AFB, OH 45433-5001

HQ AFRES/DEE/DEH/DEP (3)
ROBINS AFB, GA 31098-5000

HQ AFSC/DEE/DEP (2)
ANDREWS AFB, DC 20334-5000

HQ AFSPACECOM/DEE/DEM/DEP (3)
PETERSON AFB, CO 80914-5000

HQ ATC/DEE/DEM/DEP (3)
RANDOLPH AFB, TX 78150-5001

HQ AU/DEE/DEM (2)
MAXWELL AFB, AL 36112-5001

HQ ESC/LEEE/LEEP (3)
SAN ANTONIO, TX 78243-5000

HQ PACAF/DEE/DEM/DEP (3)
HICKAM AFB, HI 96853-5001

HQ MAC/DEE/DEM/DEP (3)
SCOTT AFB, IL 62225-5001

HQ SAC/DEE/DEM/DEP (3)
OFFUTT AFB, NE 68113-5001

HQ TAC/DEE/DEM/DEP (3)
LANGLEY AFB, VA 23665-5001

HQ USAFE/DEE/DEM/DEP (3)
APO NY 09012-5001

HQ AFESC/DEM (1)
TYNDALL AFB, FL 32403-6001

ANGSC/DEE/DEO (2)
ANDREWS AFB, MD 20331-6008

CHIEF OF ENGINEERS (3)
DEPARTMENT OF THE ARMY
ATTN: CEMP-ES/CEMP-EM/CEMP-MF
20 MASSACHUSETTS AVE
WASHINGTON, DC 20314-1000

NAVAL FACILITIES ENGINEERING
COMMAND (2)
DEPARTMENT OF THE NAVY
ATTN: CODE 04/05
200 STOVALL ST
ALEXANDRIA, VA 22332-2300

USAF RGN CIVIL ENGR-ER/RO (1)
77 FORSYTH ST., SUITE 291
ATLANTA, GA 30335-6801

USAF RGN CIVIL ENGR-WR/RO (1)
630 SANSOME ST, ROOM 1316
SAN FRANCISCO, CA 94111-2278

USAF RGN CIVIL ENGR-CR/RO (1)
1114 COMMERCE STREET, ROOM 207
DALLAS, TX 75242-0216

AFRCE-SAC/DEE (1)
OFFUTT AFB, NE 68113-5001

AFRCE-BMS/DEE (1)
NORTON AFB, CA 92409-6448

HQ USAFE/DER (3)
RAF RUISLIP ADM, UK
APO NY 09241-5000

HQ USAFA/DEMA (1)
COLORADO SPRINGS, CO 80840-5841

AFIT/DET/DEM (3)
WRIGHT-PATTERSON AFB, OH 45433-65

1100 CES/DEE/DEM (2)
BOLLING AFB, DC 20332-5000

HQ AFCOMS/DEE (1)
KELLY AFB, TX 79241-6290

HQ AAFES/ATTN: EN-CE (1)
P.O. BOX 660202
DALLAS, TX 75266-0202

ETL DISTRIBUTION LIST

HQ AFMPC/DPMSSC
RANDOLPH AFB TX 78150-6001

3700 TECHNICAL TRAINING
GROUP/CC (1)
SHEPPARD AFB, TX 76311-5000

DEFENSE MEDICAL FACILITIES OFFICE (1)
6 SKYLINE PLACE
5109 LEESBURG PIKE
FALLS CHURCH, VA 22041

HQ USAF/LEED (1)
WASHINGTON, DC 20330-5130

HQ AFOMS/SGSF (1)
BROOKS AFB, TX 78235-5000

U. S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT/CESPK-ED-T
650 CAPITOL MALL
SACRAMENTO CA 95814-4794

DASD(I) (2)
WASHINGTON, DC 20301-4001

3340 TECHNICAL TRAINING
GROUP/TTMF (1)
CHANUTE AFB, IL 61868-5000

IHS (A. A. DESIMONE) (1)
SUITE 400, 1990 M ST. NW
WASHINGTON DC 20036

HQ USAF/LEEP (1)
WASHINGTON, DC 20330-5130

HQ AFISC/SEG/IGSE (2)
NORTON AFB, CA 92409-7001

HQ AFOTEC/DE
KIRTLAND AFB NM 87117-7001

ENGINEERING TECHNICAL
LETTER

BUILT UP ROOFING GUIDE SPECIFICATION

AFESC

DIRECTORATE OF OPERATIONS & MAINTENANCE
AIR FORCE ENGINEERING & SERVICES CENTER
TYNDALL AIR FORCE BASE, FLORIDA 32403

Atch 2

US AIR FORCE

BUILT-UP ROOFING REPAIR/REPLACEMENT GUIDE SPECIFICATION

INDEX

	Paragraph	Page
Part One - General		
Description of Work	1. 1	1
Storage of Materials	1. 2	2
Coordination Requirements	1. 3	2
Materials	1. 4	2
Submittals	1. 5	2
Application Requirements	1. 6	4
Roof Protection	1. 7	4
Fire Protection	1. 8	4
Daily Cleanup	1. 9	4
Acceptance of Completed Work	1. 10	5
Operational Procedures	1. 11	5
Part Two - PRODUCTS		
Materials	2. 1	5
Bitumen	2. 2	7
Felts, Fabrics and Mats	2. 3	7
Cements	2. 4	8
Insulation	2. 5	9
Aggregate	2. 6	10
Cant and Tapered Edge Strips	2. 7	10
Fasteners	2. 8	10
Sheet Metal	2. 9	11
Wood Products	2. 10	11
Sealant	2. 11	13
Expansion Joint	2. 12	14
Felt Envelopes	2. 13	14
Part Three - EXECUTION		
General	3. 1	14
Underlayment Installation	3. 2	15
Insulation Installation	3. 3	16
Membrane Installation	3. 4	17
Flashing Installation	3. 5	18
Metal Installation	3. 6	19
Wood Installation	3. 7	20
Sealant Installation	3. 8	20
Surfacing	3. 9	21
Roof Membrane Sampling	3. 10	21
Contractor Quality Control	3. 11	22
Warranty Sign	3. 12	29
Non-Destructive Testing	3. 13	29

Part Four - QUALITY CONTROL PROCEDURES

Section A, Instructions for Completing AF Form 1063, 29

Attachments

1. Submittals
(Sub #1 BUR System Manufacturer's Certification)
(Sub #2 System Summary Sheet)
(Sub #3 Designation of Roofing Quality Controller)
(Sub #4 BUR System 20-Year Warranty/Guaranty)
2. Example of Roof Warranty Sign
3. Completed AF Form 1063 Quality Control Record
4. Specifier Notes

BUILT-UP ROOFING REPAIR/REPLACEMENT GUIDE SPECIFICATION

Part One - GENERAL

SPECIFIER: Special attention must be given to roof mounted mechanical and electrical equipment, and penetrations. Avoid locating mechanical and electrical equipment on and penetrating through the roof membrane where practical. When it is absolutely necessary to locate equipment on or penetrate through the roof membrane, comply with the following:

1. Mechanical units should be mounted on continuous wood curbs or on steel supports raised high enough above the deck to facilitate future repair or reroofing under the units. Every equipment support must be firmly fastened directly to the building structure or roof deck to help isolate vibration from the flashing.
2. Mechanical units should not restrict the flow of water. Crickets should be installed on the high side to provide good drainage.
3. Pipe projections require metal flashings called roof jacks. Their metal flanges must be set in mastic over the completed membrane and stripped-in (covered) with two or three plies of roofing felt as recommended by the BUR manufacturer.
4. Roof penetrations should never be located in valleys or drain areas.

1.1. DESCRIPTION OF WORK. Furnish the administration, facilities, materials, labor, equipment, and quality control (QC) necessary to integrate the work into the total building system so that leakage into the Built-Up Roof System (BURS) or the building does not occur. The BURS is an assembly of components including the underlayment and insulation as applicable, and roofing membrane, final surfacing, bituminous and metal flashings, and all related parts necessary to complete the assembly. The BURS manufacturer is the roofing membrane manufacturer, who may or may not manufacture and market the other components of the BURS. Complete the work to assure that the BURS satisfies the quality control standards of the BURS manufacturer's 20-year warranted system. The BUR Manufacturer Contractor's Certification, (Submittal #1), is a qualification for this contract. The contractor shall have the BURS manufacturer of the proposed roofing system execute Submittal #1 prior to contract award. The submittal may be included in the bid proposal submitted to the Air Force. QC procedures, tolerances and testing are specified in these contract documents. Nonconforming work will be rejected as a violation to these specifications.

1.2. STORAGE OF MATERIALS. Roofing materials such as insulation, felts, roll roofing, and so forth, shall be stored under cover (building, van trailers or water proof canvas tarpaulin) to protect them from rain or snow. Materials must be stored on raised platforms or pallets. Vinyl or polyethylene sheets or insulation shipping wrappers are not suitable covering and material so stored will be marked, rejected and removed from the site. Materials shall remain on the original shipping pallets or placed on raised platforms to keep them off the ground or storage surface. All rolled goods shall be stored on pallets or raised platforms ON END and not laid flat on the storage surface. Damaged or "flattened" rolls will be rejected and removed from the job site. All cants and tapered edge strips shall be protected from the weather at all times. Packaged asphalt shall be stored in a protected area to prevent contamination during storage. Wet materials shall not be used. Surfacing aggregate shall be maintained as defined by ASTM D 1863. Make sure materials are covered by the night of delivery.

1.3. COORDINATION REQUIREMENTS. Roofing operations shall be coordinated with sheet metal work so that flashings are installed to permit continuous roof surfacing operations the same day felts are installed where practical. If gravel stops or perimeter flashings are not installed on the same day as roof completion, the roof membrane at perimeters shall be nailed with large-headed nails 8 inches on-center to perimeter wood nailers and sealed against water entry with glass fabric set in roofing cement. Roofing operations shall be coordinated with roof insulation work so that all insulation applied each day is waterproofed the same day with the complete roofing system. Graveling-in may be delayed for designated roof areas where specified.

1.4. MATERIALS. Materials to be installed shall conform to applicable ASTM standards as specified. Certificates of compliance may be required from each respective material manufacturer at the discretion of the contracting officer. Certification shall be provided for all bitumen, bulk or packaged, delivered to the construction site. All materials to be installed shall be delivered to the job site bearing product labels of their manufacturer.

1.5. SUBMITTALS. Submittals 1 through 4 are included at the end of this specification. Additional submittal forms shall be obtained from the contracting officer if required. Submit requests for all changes (including resolution for variances) in writing. Do not proceed with any changes without written authorization of the contracting officer. Approvals of submittals which do not conform to the contract shall not be construed as a change unless such nonconformance is a change specifically so indicated on the submittal and approved by the contracting officer.

Specifier/Contracting Officer: Text for each required numbered submittal is located at the end of the specification; do not alter the text or format of these submittals. Some contractors cannot obtain these submittals and are therefore unacceptable. Bids that do not contain Submittal #1 or not executed prior to award shall be considered non-responsive.

1.5.1. Submittal #1. Built-Up Roofing System Manufacturer's Certification (Submittal #1). Submittal #1 is a qualification for award of this contract. It must be submitted as part of the bid, or executed prior to contract award, and be accepted by the contracting officer.

1.5.2. Submittal #2. System Summary Sheet. It must be signed by both the perspective contractor and BUR manufacturer, and submitted to the contracting officer prior to contract award. This document is tailored to present BUR project requirements to the system manufacturer who can then ascertain the technical aspects of the project and the acceptability of the design to their 20-year warranty system.

1.5.3. Submittal #3. Designation of Roofing Quality Control Controller. The most effective means to evaluate quality installation is by thorough, continuous visual examination at the time of installation, conducted by a person who is knowledgeable in roofing technology and good workmanship practices. The contractor shall designate a person to be in charge of roofing quality control. The quality controller shall have at least 5 years experience in the supervision and inspection of BUR construction and shall not be a principal or officer of the roofing contractor's company. The Air Force inspector will audit the quality control process on a daily basis. (See paragraph 3.11., CONTRACTOR QUALITY CONTROL), for specific quality control requirements. The contractor must furnish Submittal 3 as required herein, modified as necessary, to identify the person in charge of roofing quality control. This submittal must be approved by the contracting officer before the Notice To Proceed (NTP) is issued.

1.5.4. Submittal #4. Built-Up Roof System 20-Year Labor and Material Warranty/Guaranty. The manufacturer shall provide an executed copy of the 20-Year Warranty/Guaranty (Submittal #4) upon satisfactory completion of the roofing system. The warranty is to be provided to the contracting officer prior to final acceptance of the project.

1.5.5. Materials Approval. Within 10 days after award of contract, the contractor shall submit to the contracting officer, certifications from the insulation and fastener manufacturers/suppliers that the materials to be used conform to specified standards as applicable to produce the BURS manufacturer's 20-year warranted system.

1.5.6. Manufacturer Publications. Four (4) copies of the following must be submitted before start of roofing work:

1.5.6.1. Latest edition of each BURS manufacturer's published general requirements and applicable literature for each roofing system to be used on the buildings included in this contract.

1.5.6.2. Latest editions of all other applicable materials, manufacturer's products and installation literature.

1.5.7. Contractor Reporting. The following shall be submitted:

1.5.7.1. Quality Control Record (AF Form 1063). See paragraph 3.11. and Part Four. (Daily)

1.5.7.2. Suppliers certification for bitumen in hot bulk and truckloads of aggregate. (As required)

1.5.8. End of Job Submittals. Before final acceptance the contractor shall submit:

1.5.8.1. A plan view drawing of each roof showing location, size and date of each day's work; Location where each membrane sample was cut to include sample identification number, date sample was taken, and size of sample.

1.5.8.2. Submittals #2 and #4. The manufacturer shall provide the executed 20-year BUR system warranty prior to final acceptance, along with an as-built system summary sheet.

1.6. APPLICATION REQUIREMENTS. Surfaces will be inspected and approved by the contracting officer or representative immediately prior to application of roofing and flashings; said inspection to be coordinated by the Contractor. The roofing or flashing shall be applied to a smooth and firm surface free of ice, frost, moisture, dirt, projections, and foreign materials. Application of roofing shall not be performed under damp or wet conditions or excessive wind conditions as determined by the contracting officer.

1.7. ROOF PROTECTION. When wheeled or other traffic over the partially or fully completed roofing is unavoidable, use adequate plank or plywood protection for the roofing. Mechanical application devices shall be mounted on pneumatic-tired wheels, and shall be designed and maintained to operate without damaging the insulation or the roofing membrane.

1.8. FIRE PROTECTION. Provide 15-pound minimum size fire extinguishers, using ammonium phosphate firefighting agent. Locate two at each kettle, tanker, and site of hot bitumen application on the roof.

1.9. DAILY CLEANUP. Remove all debris daily from the roof. Use enclosed chute, crane and bucket or construction hoist to reduce amount of dust, dirt, and noise.

1.10. ACCEPTANCE OF COMPLETED WORK. Acceptance of completed work will be based on its conformance to the contract. Nonconforming work will be rejected. The Air Force is not obligated to accept nonconforming work at a reduced price. The contractor shall start replacement or correction of rejected work within 10 calendar days after receipt of the rejection notice. A QC program not in compliance with Part Four is considered nonconforming work. Contractor receipt of a final acceptance certificate, signed and dated by the contracting officer, will constitute Air Force acceptance of roofing work.

1.11. OPERATIONAL PROCEDURES. Confine operations, movement of workmen and equipment, storage, materials and debris within limits as directed by the contracting officer. Do not load the deck or any part of the building structure or permit to be loaded with a weight which will cause excessive deflection or endanger safety or cause damage. Do not put kettles on the roof deck or roofing systems. Protect the building and surrounding area from damage or injury. The contractor must determine the nature of these operations and provide proper protection. Repair all damage caused by lack of such protection to the contracting officer's satisfaction. If repairs are not made, or if the contracting officer determines that repairs are beyond the contractor's ability, the Air Force will have the work done by others, and will charge the cost to the contractor.

Part Two - PRODUCTS

2.1. MATERIALS. Materials shall conform to the following requirements or equivalent 20-year warranted system:

2.1.1. Applicable for the indicated slopes over all decks.

2.1.1.1. Slopes 1/8-inch per foot and less:
Aggregate-surfaced, with 4 plies of coal tar compatible fibrous glass felt and coal tar ASTM D450 Type I or III.

Specifier: If the use of coal tar products are prohibited by any federal, state or local laws, specify fibrous glass felt with ASTM D312 Type II asphalt.

2.1.1.2. Slopes 1/8 inch to 1/2 inch per foot:

2.1.1.2.1. Aggregate-surfaced, with 4 plies of asphalt-coated fibrous glass felts and asphalt, ASTM D312 Type II or Type III.

2.1.1.2.2. Mineral-surfaced, with 4 plies of asphalt-coated fibrous glass felts and an additional glass fiber cap sheet and asphalt, ASTM D312 Type II or Type III.

2.1.1.3. Slopes 1/2-inch to 3 inches per foot: Same as 2.1.1.2 except use Type III or IV asphalt.

2.1.1.4. Slopes over 3 inches per foot.

Specifier: Depending on the aesthetics desired, select either a smooth or mineral surfaced roofing. Note that an emulsion surfaced roof is maintenance intensive requiring periodic recoating to protect underlying membrane.

2.1.1.4.1. Smooth (emulsion) surfaced, with 4 plies of asphalt impregnated glass felts and asphalt.

2.1.1.4.2. Mineral-surfaced with 3 plies of asphalt impregnated glass felts and a glass fiber base cap sheet and asphalt.

2.1.2. Over Steel Decks:

2.1.2.1. Underlayment: None

2.1.2.2. Insulation: Two layers (minimum).

2.1.2.3. Insulation attachment:

2.1.2.3.1. First layer: Full mechanical fasteners as required by Factory Mutual Loss Prevention Data Bulletin 1-28, current edition, Windstorm Rating Class I-90.

2.1.2.3.2. Second layer or additional layers: Asphalt Type III or as recommended by manufacturer.

2.1.2.4. Membrane: 4-ply roofing system.

2.1.3. Over Concrete Decks:

2.1.3.1. Underlayment: One ply of asphalt-coated fibrous glass felt or heavy duty base sheet as recommended by the manufacturer.

2.1.3.2. Underlayment attachment: Asphalt or coal tar as recommended by manufacturer.

2.1.3.3. Insulation: Two layers (minimum).

2.1.3.4. Insulation attachment: Asphalt Type III or as recommended by manufacturer.

2.1.3.5. Membrane: 4-ply roofing system.

2.1.4. Over Gypsum Decks:

2.1.4.1. Underlayment: One ply asphalt-coated fibrous glass felt or heavy duty base sheet as recommended by manufacturer.

2.1.4.2. Underlayment attachment: Mechanical fasteners.

2.1.4.3. Insulation: Two layers (minimum).

2.1.4.4. Insulation attachment: Asphalt Type III or as recommended by manufacturer.

2.1.4.5. Membrane: 4-ply roofing system.

2.1.5. Over Wood Decks:

2.1.5.1. Underlayment: Five-pound rosin-sized sheathing paper overlaid with one ply of asphalt glass fiber felt or heavy duty fibrous glass base sheet as recommended by the manufacturer.

2.1.5.2. Underlayment attachment: Nails

2.1.5.3. Insulation: Two layers (minimum).

2.1.5.4. Insulation Attachment:

2.1.5.4.1. First Layer: Full mechanical fasteners as required by FM I-90.

2.1.5.4.2. Second Layer or Additional Layers: Asphalt Type III or as recommended by manufacturer.

2.1.5.5. Membrane: 4-ply roofing system.

2.2. BITUMEN.

2.2.1. Primer: ASTM D41 Asphalt Primer.

2.2.2. Asphalt: ASTM D312 type as specified herein or as determined by the slope requirements of the BURS manufacturer.

2.2.3. Coal Tar: ASTM D450, Type I or Type III or as recommended by the BURS manufacturer.

2.3. FELTS, FABRICS, MATS AND WALKWAYS.

2.3.1. ASTM D1668 Treated Glass Fabric:

2.3.1.1. Type I, for asphalt systems.

2.3.1.2. Type II, for coal tar systems.

2.3.2. ASTM D2178 Type IV or Type VI Asphalt Glass Felt used in roofing and waterproofing as recommended by the manufacturer.

2.3.3. ASTM D4601 Type II Asphalt Coated Glass Fiber Base Sheet.

2.3.4. ASTM D3909 Asphalt Roll Roofing (Glass Felts) surfaced with mineral granules.

2.3.5. Organic felts for envelops and water cutoffs.

2.3.5.1. ASTM D226 Asphalt-Saturated Organic Felt Type 2 (30-16).

2.3.5.2. ASTM D227 Coal Tar-Saturated Organic Felt.

2.3.6. ASTM 517 Asphalt Plank for Walkways.

2.3.7. Flashing: Base flashings to be standard product of the BUR manufacturer. Modified Bitument Flashing (APP or SBS modified) membranes may be used IAW manufacturers' instructions.

2.4. CEMENTS.

2.4.1. Asphalt Base Roofing Cement: ASTM D2822 Asphalt Roof Cement, Type II.

2.4.2. Coal Tar Base Roofing Cement: ASTM D4022 Coal Tar Roof Cement.

2.4.3. Flashing Cement: BURS manufacturer's standard.

2.4.4. Plastic Cement: Shall conform to FS SS-C-153 Type I Class A.

Speci fier:

1. Selection of appropriate insulation demands full knowledge of the advantages and limitations of insulation materials under consideration. Select only the insulation/insulations that meet Air Force minimum needs for the project.

2. Do not leave the insulation choice up to the contractor by providing a shopping list of insulations or alternate insulation systems. NOTE: There is only one manufacturer of glass fiber board roof insulation. When you choose glass fiber board, you may also want to specify an alternative insulation.

3. Total insulation thickness shall not exceed 6 inches between the roof deck and roof membrane except in areas of crickets which may exceed 6 inches. In all cases ensure that counterflashings are a minimum of 8 inches above the adjacent roofing membrane.

4. Ensure that the BUR membrane manufacturer will approve the use of their membrane over the Insulation system selected.

5. FS HH-I-1972/GEN must be included when an HH-I-1972 insulation is specified.

6. Install a layer (3/4 inch minimum) of perlite board, fibrous glass, or fiber board insulation between membrane and foam type insulations (polyurethane, polyisocyanurate, phenolic). Offset the joints in the top and bottom layers of insulation.

7. Insulations not listed are unacceptable on Air Force contracts. If you desire to use an insulation type that is not listed, contact your MAJCOM roofing engineer for assistance.

8. Avoid using lightweight insulating fill materials. All proposals to use such materials or to reroof over existing lightweight fills must be approved by the appropriate MAJCOM roof engineer.

9. Thickness of Insulation: Installed thickness of insulation shall be such as to provide a coefficient of heat transmission or U-value, through the completed roof construction air-to-air, not in excess of Btu per hour, per square foot, per degree F temperature difference, when determined for winter conditions. The thickness of polyisocyanurate or polyurethane insulation or the polyurethane component of composite board insulation shall be calculated using a K-value of 0.18. Roof construction air-to-air may include finish ceilings, provided unceilinged areas do not occur under the same roof area or space above the ceiling is not vented to the exterior or used as an air plenum. (Mechanical rooms without ceilings need not be considered when computing the required thickness of insulation.) Insulation thickness shall be uniform over common roof areas. Minimum thickness of insulation shall be as recommended by the insulation manufacturer.

2.5. INSULATION.

2.5.1. Mineral Fiber, and Mineral Fiber Rigid Cellular Polyurethane Composite Roof Insulation Board, ASTM C 726.

2.5.2. Perlite Thermal Insulation Board, ASTM C 728. Perlite board shall be treated to reduce asphalt adsorption.

2.5.3. Insulating Board (Cellulosic Fiber) Structural and Decorative, ASTM C 208.

2.5.4. Federal Specification (FS) HH-I-1972/GEN Insulation Board, Thermal Faced, Polyurethane or Polyisocyanurate.

2.5.4.1. FS HH-I-1972/2 Insulation Board, Thermal, Polyurethane or Polyisocyanurate Faced with Asphalt/Organic Felt, Polymer/Organic mat, Asphalt/Glass mat, or Polymer/Glass mat on both sides of the foam, Class I.

2.5.4.2. FS HH-I-1972/3 Insulation Board, Thermal, Polyurethane or Polyisocyanurate Faced with Perlite Insulation Board on one side of the foam and Asphalt/Organic Felt Style 1 or Asphalt/Glass Fiber Felt on the other side of the foam, Style 2.

2.5.4.3. FS HH-I-1972/5 Insulation Board, Thermal, Polyurethane or Polyisocyanurate Faced with Perlite Board on both sides of the foam.

2.5.5. Phenolic Insulation. Phenolic insulation shall be closed cell phenolic foam board with a density in excess of 2.5 pounds (minimum) per cubic foot. The top and bottom surfaces of the board shall be covered with an uncoated glass facer bonded to the phenolic foam during manufacture. Phenolic insulation shall conform to physical requirements of FS HH-I-1972/2, Class 1. Test data shall be submitted to demonstrate compliance.

2.6. AGGREGATE. ASTM D 1863 Mineral Aggregate used on built-up roofs, graduation size 6, 7, or 67.

Specifier: Where ASTM D 1863 aggregate is not locally available, other types of aggregate may be used with prior approval from the contracting officer.

2.7. CANT AND TAPERED EDGE STRIPS.

2.7.1. ASTM C 208 Insulating Board (Cellulosic Fiber), Structural and Decorative, ASTM C 726 Mineral Fiber and Mineral Fiber, Rigid Cellular Polyurethane Composite Roof Insulation Board, or as recommended by the BURS manufacturer.

2.7.2. Size:

2.7.2.1. Cants: 4 inch X 4 inch or as required by conditions. In high wind areas, install cants in compliance with FM I-90.

2.7.2.2. Tapered Edge Strips: 1-1/2 inch X 18 inches or as required by conditions.

2.8. FASTENERS.

2.8.1. Nails: Nonferrous or galvanized steel

2.8.2. Bolts and Nuts: ASTM A307 Carbon Steel Externally and Internally Threaded Standard Fasteners, hot-dip galvanized.

2.8.3. Roofing Fasteners: Fasteners used to fasten to steel, wood and gypsum decks must be approved by FM as evidenced by being listed in the FM Approval Guide for I-90 windstorm rating when used with the specified insulation. Fasteners shall be the threaded type that will fill the penetration through the deck. Fasteners shall be treated to prevent corrosion according to FM Std 4470.

2.8.4. Underlayment, Roof Membrane, and Base Flashing Fasteners: Types as recommended by the BURS manufacturer.

2.8.5. Sheet Metal Fasteners:

Metal Type	Fastener Material
AAAAAAAAAA	AAAAAAAAAAAAAAAAAA
Galvanized Steel	Galvanized or Cadmium Plated steel
Copper	Copper or Bronze
Lead	Galvanized or Cadmium-plated steel
Lead-coated Copper	Copper or Bronze

Specifier: The galvanized steel specified can be painted or
factory prefinished.

2.9. SHEET METAL.

2.9.1. Galvanized Steel: ASTM A526 hot-dipped zinc-coated sheet steel, commercial quality. Coating designation G 90, not chemically treated, not oiled, phosphatized.

2.9.2. Copper: ASTM B370 copper sheet and strip for building construction, cold-rolled temper.

2.9.3. Lead: Manufactured from a base metal conforming to FS QQ-L-171E Lead Pig, Grades A or C or ASTM B29 Pig Lead, chemical lead type modified as follows: Hard lead containing 4 to 6 percent antimony, and the remainder lead or hard lead containing 3.75 to 4.25 percent antimony, 0.07 to 0.10 percent arsenic.

2.9.4. Lead Coated Copper: ASTM B101 lead coated copper sheets, Type I, Class A, 16 ounce per square foot minimum weight copper exclusive of coating, cornice temper for cornices and roofing temper for all other metal work.

2.9.5. Solder, Flux, and Accessories: As necessary and compatible with the material being installed.

2.9.6. Pre-finished Galvanized Steel: ASTM A 526, Steel Sheet, Zinc-Coated (Galvanized) by the Hot-dip Process, Commercial Quality, coating designation G 90, not chemically treated, not oiled, phosphatized. Factory pre-finished galvanized steel shall be primed and coated with a full strength fluoropolymer (containing a minimum of 70% Kynar 500 resin). Color shall be selected by the contracting officer but shall be a standard factory color to match or complement the existing color scheme. Provide the manufacturer's 20-year warranty.

2.10. WOOD PRODUCTS.

2.10.1. Lumber Species. Choose from the following: Douglas fir, northern white pine, ponderosa pine, southern pine, jack pine and red pine.

2.10.2. Grades. Choose either Western Wood Products Association (WWPA), Northeastern Lumber Manufacturers Association (NELMA), or Southern Pine Inspection Bureau (SPIB) grading rules for the specified grades for Lumber provided. Plywood panels shall meet the requirements of the latest edition of U.S. Product Standard PS 1.

2.10.2.1. Exterior trim, soffits, and wood exposed to view.

2.10.2.1.1. Lumber:

2.10.2.1.1.1. WWPA and NELMA: Selects and finish class, "D" Select Grade or

2.10.2.1.1.2. SPIB: "C" Finish Grade.

2.10.2.1.2. Plywood: American Plywood Association (APA), veneer grade A-C, plywood, exterior.

2.10.2.2. Enclosed and incorporated into the roof system (for example, nailers, sleepers, blocking, and decking):

2.10.2.2.1. Lumber:

2.10.2.2.1.1. Thickness less than 2 inches, and all widths: WWPA and NELMA; Board Class No. 2 common grade or SPIB No. 1 boards.

2.10.2.2.1.2. 2 to 4 inches thick, and 2 to 4 inches wide: SPIB, WWPA, and NELMA: Structural light framing class, No. 2 grade.

2.10.2.2.1.3. 2 to 4 inches thick, and 4 inches and over in width: SPIB, WWPA, and NELMA: Structural joists and planks Class, No. 2 grade.

2.10.2.2.2. Plywood for all uses except decking, choose from the following:

2.10.2.2.2.1. APA, veneer grade C-C plugged, plywood, exterior.

2.10.2.2.2.2. APA, veneer grade C-D plywood, Exposure 1.

2.10.2.2.2.3. APA, Structural I or II Rated Sheathing, Exterior.

2.10.2.2.2.4. APA, Structural I or II Rated Sheathing, Exposure 1.

2.10.2.2.3. Plywood for decking:

2.10.2.2.3.1. APA, veneer grade C-C, plywood, Exterior.

2.10.2.2.3.2. Minimum 1/2-inch thickness required.

2.10.3. Preservative Treatment:

2.10.3.1. Exterior trim, soffits, and wood exposed to view: Do not treat with preservatives.

2.10.3.2. Enclosed and incorporated into the roof system: American Wood Preservers Bureau (AWPB) specification LP 22 standard for lumber, timber, and plywood pressure treated with water-borne preservatives for ground contact use. (July 1975), except, do not use acid copper chromate (ACC) preservative. Dry preservative-treated wood products after treatment to values specified in LP 22.

2.10.4. Moisture: The allowable moisture content for lumber and plywood is to be 12 percent. For exterior trim, soffits, and wood exposed to view, the moisture content applies at the time it is painted. For wood enclosed and incorporated into the roof system, the moisture content specified in LP 22 applies at the time of enclosure.

2.10.5. Marking:

2.10.5.1. Each piece of lumber must bear a grade stamp or grade mark showing the association under whose rules it was graded, the grade, the species, and either "S-DRY," "KD," or "MC 15."

2.10.5.2. Each panel of plywood must bear the appropriate trademark of the American Plywood Association (APA).

2.10.5.3. Each piece of preservative-treated lumber and plywood must bear the AWPB quality mark.

2.11. SEALANT.

2.11.1. Sealant Primer. As manufactured and recommended by the sealant manufacturer in writing. All sealants must be used with a primer. If a manufacturer does not routinely require a primer, obtain a recommendation to fill this requirement.

2.11.2. Sealant Backup Material. As manufactured or recommended by the sealant manufacturer for the substrate type and joint design on this project. Unless indicated or specified otherwise, all joints must have a backup material sized to be slightly compressed in the joint when installed.

2.11.3. Color. As specified herein or, if unspecified, to match the adjacent substrate as closely as possible with standard stock colors.

2.11.4. Sealant type for general use. FS TT-S-230C including amendment 2 single component sealing compound, Type II, Class A. Sealant material must be urethane or acrylic polymer.

2.11.5. Use sealants whose date of manufacture shows they have not exceeded their shelf life. Do not use sealants with a date of manufacture more than 12 months old.

Specifier: Follow recommendations of SMACNA Architectural Manual or the NRCA Construction Details for metal cap-type roof expansion joints. For elastomeric expansion joints, follow the NRCA Construction details for roof-on-roof expansion joints and the manufacturer's details for roof-to-wall expansion joints. In seismic zones 2, 3 and 4, non-reinforced elastomeric expansion joints are preferred over metal. Specify one of the following flange metals: 26-ga. galvanized steel, 0.018" stainless steel, and 16 oz. copper.

2.12. EXPANSION JOINT. Metal cap type roof expansion joints are to be installed on wood curbs extending 8 inches minimum above the roof. Metal cap-type shall be manufactured in accordance with the recommendations of the NRCA. Elastomeric-type shall have a non-reinforced EPDM or neoprene bellows with a foam backing, and it shall be mechanically interlocked to the metal mounting flanges with a continuous bifurcated metal edge crimp. All intersections shall be prefabricated by the manufacturer.

2.13. FELT ENVELOPES: ASTM D226 Asphalt-Saturated Organic Felt, Type II or ASTM D227 coal-tar saturated organic felt.

Part Three - EXECUTION

3.1. GENERAL.

3.1.1. APPLICATION OF ROOFING. The entire roofing system, excluding aggregate surfacing, shall be finished in one operation up to the line of termination at end of day's work. Application of roofing shall immediately follow application of insulation as a continuous operation. Phased construction will not be permitted. BURS and graveling-in shall be installed according to BURS manufacturer's requirements and specifications. To ensure a waterproof membrane, care shall be taken to preclude bare spots (voids) between plies. To prevent slippage, care shall be taken to preclude use of excessive amounts of bitumen. Kettle attendants shall be present at the kettle at all times during the heating. Application temperatures shall be measured at the mop bucket or mechanical applicator. Asphalt shall be applied at or no less than 25 degrees (F) below the manufacturer's stated EVT. Asphalt at a temperature below this shall be returned to the kettle. Coal tar shall not be heated above 410 degrees (F) for ASTM D 450, Type I and 425 degrees (F) for ASTM D 450, Type III. Coal tars shall be applied at the roofing felt manufacturer's recommended temperature range. Coal tar at a temperature below this range shall be returned to the kettle. The surface of the felts shall be broomed-in full width to obtain complete adhesion between plies and to eliminate air pockets. The method of mopping a half sheet width and turning the sheet back to mop under the other half will not be used.

Workers shall avoid walking on mopped surfaces when the bitumen is sticky. Each layer of roofing felt shall be carried up abutting vertical surfaces at least 4 inches, or the top of the cant strip.

3.1.2. Preparation For Roofing (Work Item #7):

1. Removals must result in a clean and dry substrate, except for residual stains, providing a surface suitable to apply new materials. A substrate surface is suitable when application of new materials results in a uniform positive, and maximum bond between such materials and the substrate.

2. Remove existing roof-top equipment as indicated on the drawings; all equipment remains Government property unless otherwise designated.

3. Lift or remove metal and metal accessories indicated to remain, to aid the installation of new materials.

4. If conditions are uncovered or created that would be detrimental to the application of specified work, immediately notify the Contracting Officer of such conditions for determination of treatment.

5. Roof drains are to be removed, replaced and/or adjusted as indicated to accommodate the new roofing system. Existing drainage system shall be protected during construction. Tapered insulation around the roof drains shall be provided as shown in the standard NRCA roof drain details.

3.2. UNDERLAYMENT INSTALLATION.

3.2.1. Concrete Decks. Prime the deck with a uniform coating of asphalt primer at the rate of one gallon per square and allow to dry. Apply one ply of the specified felt underlayment in a strip or spot mopping of hot and fluid asphalt with 2-inch side laps and 6-inch end laps minimum per manufacturer's specifications. NOTE: On precast concrete decks, joints shall be treated as recommended by BURS manufacturer, and primer and asphalt moppings shall be held back 4 inches minimum from panel joints.

3.2.2. Gypsum Decks. Apply one ply of the specified felt underlayment with 4-inch side laps and 6-inch end laps minimum. Attach with specified mechanical fasteners through side laps on 6 to 9-inch centers. Also, stagger nail center of sheets at approximately 18 inches on-center, in two parallel rows, 10 to 12 inches from the edges of the base ply. Do not drive fasteners into or between the metal edges of the gypsum planks.

3.2.3. Wood Decks.

3.2.3.1. Completely cover the deck with one ply of sheathing paper. Lap each sheet a minimum of 2 inches and nail sufficiently to hold in place.

3.2.3.2. Over the sheathing paper, apply one ply of the specified felt underlayment with 2-inch side laps and 6-inch end laps minimum. Nail through side laps on 6 to 9-inch centers and stagger-nail center of sheets at approximately 18 inches on center in two parallel rows, 10 to 12 inches from the edges of the base ply.

3.3. INSULATION INSTALLATION.

Specifier: Include paragraph 3.3.1. for all projects requiring insulation.

Specifier: It is the specifiers responsibility to determine the need of a vapor retarder. If a vapor retarder is required over steel deck construction, add the following new paragraph:
"3.3.1.5. Vapor Retarder. Over the first layer of insulation on steel decks, install two plies of Type II Fiberglass felt in shingle fashion with 6-inch end laps or per manufacturer's instructions. Install felts in full and continuous moppings of hot asphalt, applied at the same rate as that for the primary membrane plies."

3.3.1. General Requirements:

3.3.1.1. On slopes of 1 inch per foot or more, provide pressure treated wood insulation stops according to the roof insulation manufacturer's requirements.

3.3.1.2. Secure cant and tapered edge strips in place with asphalt; cut and neatly fit all joints and miters. Cant strip may be tacked in-place for ease of installation (approximately 3 nails every 4 feet).

3.3.1.3. Insulation board, cant strips and tapered edge strips that can be readily lifted or displaced by hand are not adequately secured. Reinstall all lifted and displaced items that are not damaged. Replace damaged items with new material.

3.3.1.4. Follow additional applicable requirements of the roof insulation manufacturer and BURS manufacturer.

Specifier: When a coal tar roof is specified and an acoustical or perforated metal deck is used, add new paragraph "3.3.2.3." below to tape joints on second layer of insulation to minimize the potential for bitumen drippage.

3.3.2. Over Steel, Wood and Gypsum Decks.

3.3.2.1. First (bottom) layer:

3.3.2.1.1. Place insulation so that side joints between boards are fully supported at all times.

3.3.2.1.2. Stagger end joints by a minimum of 6 inches; bring boards into moderate, uniform contact.

3.3.2.1.3. Also, secure all insulation boards in the first layer with mechanical fasteners over the entire roof deck according to FM Loss Prevention Data Sheet 1-28. Filler pieces must have at least two fasteners. Locate all fasteners such that there is at least 1 fastener every 2 square feet, or comply with FM Windstorm Class FM I-90, whichever is more stringent.

3.3.2.1.4. Use those driving methods prescribed by the fastener manufacturer.

3.3.2.2. Second or additional layers. Secure in full and uniform moppings of hot, fluid bitumen; stagger end joints by minimum 6 inches; bring boards into moderate, uniform contact at sides and ends while the bitumen is hot and fluid. Offset all joints between layers by maximum dimensions in both directions.

3.3.3. Over Non-Nailable Decks With Underlaments.

3.3.3.1. Secure all insulation boards in full and continuous moppings of hot fluid bitumen.

3.3.3.2. Stagger end joints by minimum 6 inches. Bring boards into moderate, uniform contact at sides and ends while the bitumen is hot and fluid. Offset all joints between layers by maximum dimensions in both directions.

3.4. MEMBRANE INSTALLATION.

3.4.1. General Requirements. Except as modified and supplemented herein, apply membrane (4-ply) to meet the quality standards of the BURS manufacturer's 20-year warranty system. On slopes over 1 inch per foot, provide nailers and backnail felts, and if required by the BURS manufacturer on lower slopes.

3.4.2. Felts and Roll Goods.

3.4.2.1. Apply felts shingle fashion and maintain proper lap distance to result in a 2-inch nominal headlap (1-inch minimum, no maximum). Maintain a straight run of felts so that kinks or fishmouths do not result, and the felts are completely flat.

3.4.2.1.1. Bitumen Dams. Felt envelopes shall be provided at the eaves and rakes and sheet metal dams at deck penetrations to prevent bitumen drippage. Felt envelopes are required for membranes using coal-tar pitch, Type I and Type II asphalt bitumen. Sheet metal bitumen dams shall be installed with the flange set in plastic cement on top of the insulation. Roofing felts shall be applied over the flanges with the sleeve of the dam set to prevent drippage of bitumen.

3.4.2.1.2. Edge envelopes shall be organic felt strips at least 18 inches wide. The strip shall be set in plastic cement or Type IV asphalt and positioned to extend 9 inches onto the nailer around the perimeter of the building with 9 inches lapped over the edge of the building. After roofing felt application is complete, the 9-inch overlapped section shall be folded back over the plies and mopped down to form an envelope around the perimeter of the membrane.

Speci fier: Embedded metal gravel stops are not a good practice and should be avoided where possible. When used, gravel stops should be raised above the water line when possible by using wood blocking and tapered cant strips. See NRCA standard construction details.

3.4.2.2. Once established, do not change the direction of felt application. Provide organic felt envelopes at gravel stop roof edges and sheet metal pitch dams at deck penetrations to prevent bitumen drippage.

3.4.2.3. Broom or squeegee each ply of roll goods into place, full width, while the bitumen is hot and fluid, such that felt does not touch felt and interply voids or skips in the bitumen do not occur. Broom or squeegee and do not walk on the freshly laid felt until bitumen has reached set temperature. Bitumen shall be visible continuously along both edges of the felt. NRCA Publication, Application Techniques for Glass Fiber Roofing Felts, shall be used as a recommended procedure.

3.5. FLASHING INSTALLATION.

Speci fier: Include paragraph 3.5.1. for all projects requiring flashing.

3.5.1. General Requirements (Work Item #13). Install flashings as detailed on the drawings and/or as recommended by the manufacturer. Modified Bitumen (MB) type membranes may be used if approved and installed per BUR manufacturer's instructions (torched, hot, cold applied, etc).

3.5.1.1. Prime all surfaces to be flashed with asphalt primer and allow to dry.

3.5.1.2. Completely bond all flashings to the substrate, and the flashing plies to each other without voids. Coat all flashing substrate and ply interfaces to achieve a full and uniformly bonded laminate. Flashing cement shall be applied in a continuous layer. Brushing application is not acceptable.

3.5.1.3. Follow additional applicable published requirements of the BURS manufacturer.

3.5.1.4. Tops of all membrane base flashings must be mechanically attached to the vertical substrate with large-headed nails 6 to 9 inches on-center.

3.5.1.5. All side laps of membrane flashing surfacing sheets must be sealed with roofing cement reinforced with woven glass fiber 4 inches wide centered over the lap.

3.5.1.6. Tops of all membrane base flashings must be sealed with roofing cement reinforced with 4-inch wide woven glass fiber fabric.

Specifier: Include paragraph 3.5.2. on projects with internal roof drains.

3.5.2. Roof Drain Flashing. Follow applicable published requirements of BURS manufacturer or NRCA published details and procedures.

*****%*****
Specifier: Delete paragraph 3.5.3. if not applicable to the project.

3.5.3. Expansion Joint Covers. Install expansion joint covers as detailed and recommended by NRCA, or Sheet Metal and Air Conditioning Contractors National Association, Inc., (SMACNA). Install and splice in accordance with the manufacturer's installation instructions. Use only fasteners and splicing materials, including adhesives, supplied for this purpose by the manufacturer.

Specifier: Discard all sheet metal that would have to be removed or bent in order to install the new system. Sheet metal can never be restored to its original condition, and it is false economy not to install all new metal.

3.6. METAL INSTALLATION.

3.6.1. Fabricate and install metal as shown on drawings. Meet the requirements of the components of materials manufacturers, NRCA, SMACNA, and Copper Development Association, as they apply to this project.

3.6.2. The contractor is responsible for all the work required to make any displaced mechanical units operational. Included are repair, testing, and balancing to conform to the original level of performance as determined by the Contracting Officer.

3.6.3. Prime all sheet metal that will come in contact with bituminous materials with asphalt primer and allow to dry before applying bitumen.

3.6.4. Isolate dissimilar metals in contact by painting with a compatible bituminous coating, or by using an uncured neoprene gasket.

3.6.5. Sheet Metal with Flanges: Follow applicable published requirements of BURS manufacturer.

3.6.6. Do not overlap edge metal. Allow 1/4-inch minimum spacing between edge metal pieces. Cover gap between adjacent edge metal with a joint cover 4 to 6 inches wide set in mastic.

3.7. WOOD INSTALLATION.

3.7.1. Provide wood members as indicated on drawings.

3.7.2. Provide fasteners at not more than 2 feet 8 inches on-center, and also within approximately 6 inches of each end to secure nailers to the building construction. Anchors shall be not less than 3/8-inch in diameter and shall be countersunk and flush with top of nailer.

3.7.3. Where nailers are stacked, secure the top nailer to the lower with spikes or nails of proper length, spaced maximum 18 inches on-center, staggered and within approximately 6 inches of all nailer ends. Ends of stacked nailers shall be offset approximately 12 inches in long runs and staggered (alternated) at corners.

3.7.4. Brush apply one coat of copper naphthenate solution onto all cut surfaces of preservative-treated lumber.

3.7.5. Wood cants are to be used in critical wind areas and securely anchored to prevent warping.

3.8. SEALANT INSTALLATION.

3.8.1. Follow sealant manufacturer's installation requirements except as specified herein.

3.8.2. Clean the substrate so no contaminants such as bitumen, concrete curing compound, paint, dirt, or moisture will prevent bonding of the primer or sealant directly to the substrate.

3.8.3. Prime with sealant primer, all substrates to which sealant will be applied and allow the primer to cure. This must be done regardless of whether the sealant manufacturer requires priming.

3.8.4. Except for sheet metal joints, install sealant backup material.

3.9. SURFACING.

SPECIFIER: A designated roof area is defined as a natural building division such as upper and lower roofs, areas divided by expansion joints, separate wings of a building and areas divided by firewalls. Graveling-in can be delayed as recommended by the BUR manufacturer. See NRCA publication, "Application Techniques for Glass Fiber Roofing Felts".

3.9.1. After roofing felts have been laid and flashings installed, the roof surface shall be flood-coated uniformly and appropriate aggregate surfacing applied according to BURS manufacturer requirements and specification.

Specifier: Include paragraph 3.9.3. for projects with aggregate surfaced roofs in the vicinity of aircraft warm-up and operating aprons.

3.9.2. Walkways. Where shown, mineral-surfaced asphalt plank treads, meeting the requirements of ASTM D517, shall be embedded in the flood coat prior to gravel surfacing. Treads shall be spaced 6 inches apart. If pavers, grating or any other walkway system is specified, install in accordance with the BUR manufacturer recommendations.

3.9.3. Building No. _____ is in the vicinity of aircraft operations. Apply aggregate surfacing as follows:

3.9.3.1. Over the entire surface of the roofing membrane apply a continuous coating of bitumen and sufficient aggregate to completely cover the surface. Remove loose gravel.

3.9.3.2. Apply a second continuous coating of bitumen and sufficient aggregate to completely cover the area. Loose aggregate must be removed from the final surface resulting in complete aggregate embedment.

3.10. ROOF MEMBRANE SAMPLING (Work Items #10 and #11).

3.10.1. A minimum of one test cut 12 inches X 12 inches in dimension is required each day of construction until a level of confidence is established between the quality controller and the government inspector. The contractor will take the required test at the direction of the contracting officer or his/her designated representative. A test cut of same dimensions is also required when job conditions change significantly thereafter, such as, ambient temperature, crew members, or when visual observations indicate that membrane integrity may be compromised, such as, bitumen too cool, workers walking on freshly laid felts, or continuous bitumen film not present at edge of felts. Remove the test samples before application of the surface coating at locations selected by the inspector. Immediately take the sample off the roof and cool it to about 0 degrees (F), using dry ice. Comply with stated tolerances on interply bitumen weight, head laps and void content. If results show out-of-tolerance conditions, the construction process will be adjusted and an additional sample taken to verify that construction is back within tolerance.

3.10.2. Sample removal and repair of the roof shall be done by the contractor. Do not cut a sample from a completed membrane until it has cured for at least two hours. Using a template and utility knife, cut the membrane a little at a time. Ensure that you cut through the entire membrane. Any bitumen that sticks to the insulation after the sample is removed shall be carefully removed and included with the sample for weighing and analysis. Remove the cut sample slowly taking care not to bend the sample.

3.10.3. Repair the sampled area immediately after taking the sample. Install a new piece of insulation, if necessary. Fill remaining void level with layers of cut felts of the same type as the roofing system, set in plastic cement. Cover repaired area with four layers of felt. (1) Solid mop each layer into place in hot bitumen. (2) Overlap test cut area 3 inches on all sides with first layer. (3) Lap each succeeding layer 3 inches on all sides over layer below.

3.10.4. Testing and analyses shall be done in accordance with ASTM D3617, Standard Practice for Sampling and Analysis of Built-Up Roof Membranes. Samples shall be tested in the field by an approved commercial testing laboratory at the contractor's expense.

3.10.5. Nonconforming work. If insufficient headlap, deficient asphalt quantities, unacceptable voids or other defects are present, the roofing system manufacturer shall be requested to furnish written recommendations for remedial action.

3.11. CONTRACTOR QUALITY CONTROL.

3.11.1. It is the responsibility of the contractor to ensure that the designated roofing quality control person complies with all requirements relating to the roofing work. To accomplish

this, the quality controller must observe work in progress, including observation of testing and measuring conducted by the Air Force inspector (e.g., audit procedures), and report work conditions daily on AF Form 1063, Quality Control Record. Instructions on how to use it are included in Part Four. Work accomplished on a daily basis will be considered satisfactory only when the daily record form shows that all "variances" have been corrected and that the work is in conformance with the contract.

3.11.2. Quality Assurance (QA).

3.11.2.1. As specified herein, provide the QA evidence needed to establish confidence that quality control (QC) is being performed adequately.

3.11.2.2. Except as modified and supplemented herein, follow the published requirements and written recommendations of the BURS and other materials manufacturers. Concerning methods of installation, industry practices apply only when this contract does not address the matter.

3.11.2.3. The specified QC requirements are minimums. Provide additional QC, if in the opinion of the Contracting Officer, the QC is not effective enough to provide conforming work. This additional QC does not constitute a change to the contract.

3.11.2.4. The QC is subject to audit by an Air Force inspector. Provide the inspector all information necessary for this audit.

3.11.2.4.1. The Air Force is not obligated to inspect a contractor's work or to protect a contractor from the consequences of such work. Air Force inspection is a general examination of the contractor's conduct and work, and is solely for the purposes of the Air Force. Air Force inspectors do not have the authority to accept any work, whether or not it is conforming. Air Force inspection is not to be construed as conclusive. Information that may be offered to the contractor does not change the contract.

3.11.2.4.2. Air Force agents, including inspectors, engineers and quality assurance evaluators, are not authorized to change the contract without the written authorization of the contracting officer. This lack of authority extends to all situations in which the actions of these agents could be construed as constituting a change.

3.11.3. Provide quality control defined as follows:

3.11.3.1. Quality control is the regulatory process by which the contractor measures actual quality performance, compares it with standards, and acts on the difference. The quality function is the entire collection of activities through which fitness for use is achieved.

3.11.3.2. Contractor inspection is a careful and critical investigation of all work to assure that it conforms to the contract, and to detect variances and act to correct them in time to prevent reworking and delay. This includes detailed, skillful examination and testing with immediate comparison to the requirements of the contract. On discovery of variance the contractor shall immediately institute corrective action to eliminate the variance and to insure that all future work conforms to the requirements of the contract.

3.11.3.3. The quality controller shall have at least 5 years' experience in the supervision and inspection of BUR construction. The quality controller shall not be a principal or officer of the roofing contractor's company. The designated QC shall always be on the job site during BUR construction.

Specifier: NOTE. At contract award, the Air Force may hire an autonomous trained field auditor. This individual has responsibility to ensure that the QC requirements of this contract are met. This individual is the technical advisor to the contracting officer and reports contract variances with recommended corrective actions immediately upon occurrence to the contracting officer and replaces the Air Force inspector.

3.11.3.4. Within 10 days after the issuance of the Notice to Proceed and before the start of roofing work, the contractor shall attend a preconstruction conference at the air base to review the contract. The quality controller and foreman or superintendent must attend the conference. A technical representative from both the membrane and insulation manufacturers shall also be present at this conference, if requested. These representatives shall be knowledgeable in the installation peculiarities and compatibility of their product. The contractor shall give an oral presentation of proposed construction method. The manufacturers' representatives shall provide input where necessary to describe the proper installation of their materials. The conference may include a visit to the work site, and a slide or video presentation relating to job site membrane sampling and analysis.

3.11.3.5. Basic quality control requirements are contained in Part Four of this specification. As a minimum, the quality controller shall perform each of the actions listed in Part Four on a daily basis. Failure to perform these actions is a failure to prosecute the work with such diligence that will ensure its compliance with tolerances specified in this contract and is grounds for the contracting officer to stop the work.

3.11.4. Preparatory Inspection. (To be conducted prior to commencing work)

3.11.4.1. Before actual work begins, the quality controller must:

- 3.11.4.1.1. Read the specifications and study the drawings.
- 3.11.4.1.2. Understand the required tests and measurements.
- 3.11.4.1.3. Understand AF Form 1063, Quality Control Record, and reporting procedures. (See Part Four).
- 3.11.4.1.4. Visit the roof and become familiar with its layout.
- 3.11.4.1.5. Attend the pre-construction conference.
- 3.11.4.2. The quality controller shall supply the following equipment for tests and measurements required to be performed under this contract:
 - 3.11.4.2.1. Calibrated portable thermometer to measure the bitumen temperature at the kettle and at the point of application.
 - 3.11.4.2.2. Triple beam scale or postal-type platform scale for weighing roof membrane samples.
 - 3.11.4.2.3. Non-conductive measuring tape, 50 or 100 feet.
 - 3.11.4.2.4. Hand held Delmhorst Model BD-7 Moisture Meter or approved equal for determining moisture content of materials at time of installation.
 - 3.11.4.2.5. Sheet metal template (4 inches X 40 inches and 12 inches X 12 inches) for BUR samples. (Reference ASTM D3617.)
 - 3.11.4.2.6. A capability for cooling BUR samples to a temperature of at least 0 degrees (F) in 30 minutes.
 - 3.11.4.2.7. Tools required for cutting samples and splitting felt plies apart (cutting knife and blades).
 - 3.11.4.2.8. Clear template with 1/2-inch grid for analyzing sample void area.
 - 3.11.4.2.9. MIL gauge for measuring flood coat thickness.
- 3.11.4.3. Allowable Tolerances. The following tolerances establish the range of acceptable variances. The quality controller shall review these tolerances and ensure that work is in compliance. Follow manufacturer recommendations as they apply to their 20-year warranted system. If Air Force requirements are more stringent, follow them. The work item listed after each tolerance should be used to assure compliance with this specification.
 - 3.11.4.3.1. Headlap: Minimum 1 inch, no maximum. (Work Item #9).

- 3.11.4.3.2. Endlap: Minimum 4 inches, no maximum. (No Work Item).
- 3.11.4.3.3. Insulation board joint gaps: 3/16-inch maximum between boards and 1/4-inch maximum between boards and abutting surfaces. (Work Item #8).
- 3.11.4.3.4. Bitumen temperatures: (Work Item #2).
- 3.11.4.3.4.1. Maximum at kettle: Do not heat ASTM D312, Type I asphalt above 500 degrees (F) and all other ASTM D312 type asphalt above 525 degrees (F). Do not heat coal-tars above 410 degrees (F) for ASTM D450, Type I and 425 degrees (F) for ASTM, Type III.
- 3.11.4.3.4.2. Temperature at point of application: Equiviscous Temperature (EVT) plus or minus 25 degrees (F).
- 3.11.4.3.4.3. Holding temperature: Do not heat and hold asphalt between 500 - 525 degrees (F) for more than 4 hours. Overnight holding temperature for asphalt shall not exceed 325 degrees (F). If heating of coal-tar is desired during a non-use period, temperature shall not exceed 325 degrees (F). If storage exceeds 4 hours, kettle shall be shut off. Large quantities of coal-tar, 1000 gallons or more, can be held at a maximum of 300 degrees (F) for no more than 96 hours.
- 3.11.4.3.5. Interply moppings: As required by the BUR manufacturer plus or minus 20 percent. (Work Item #10).
- 3.11.4.3.6. Flood coat: Asphalt, 60 pounds per square average and at no location less than 50 pounds; coal tar, 70 pounds per square average and at no location less than 60 pounds. (Work Item #14).
- 3.11.4.3.7. Surfacing: Uniformly cover roof area with the quantity of aggregate specified by the BUR manufacturer. Embedded by weight, a minimum of 50 percent of the specified amount. (Work Item #14).
- 3.11.4.3.8. Foaming hot bitumen at point of application: Not acceptable for ply mopping construction. (Work Items #1 and #10).
- 3.11.4.3.9. Foreign materials between plies: None acceptable. (Work Item #9).
- 3.11.4.3.10. Material variance from specified: None acceptable. (Work Item #3).
- 3.11.4.3.11. Variance from number of plies specified: None acceptable. (Work Item #9).
- 3.11.4.3.12. Phased construction of membrane felts: Not acceptable. (Work Items #4 and #9).

3.11.4.3.13. Material moisture content: Maximum percent by dry weight as follows: Organic felts 2.5 pct; fiberglass felts 1 pct; lumber and plywood 12 pct; insulation as per manufacturer requirements. (Work Item #1).

3.11.4.3.14. Felt laying: Wrinkles, buckles, kinks and fishmouths: Not acceptable. (Work Item #9).

3.11.4.3.15. Interply voids for individual sample: (See Work Item #10 for description of voids).

3.11.4.3.15.1. Maximum area of all glazed voids: 5 percent of interply area for individual sample.

3.11.4.3.15.2. Unsealed and dry voids (felt on felt): Not acceptable.

3.11.4.3.15.3. Overlapping voids between 2 or more plies: Not acceptable.

3.11.4.4. Quality Control Record: The quality controller shall complete AF Form 1063 daily. (See Part Four of this specification).

Specifier: Edit this Part to suit the project requirements, unless excepted by Specifier note. Do not modify the text unless necessitated by the above. Renumber text as applicable.

3.11.5. Initial Inspection: (To be conducted after a representative sample of the work is complete.)

3.11.5.1. Review each significant feature and segment of the work each day.

3.11.5.2. Deliver all materials to the site, except those in quantity (bitumen in hot bulk and truckloads of aggregate) with packaging intact and with readable labels. Use those materials having labels that:

3.11.5.2.1. Identify the material.

3.11.5.2.2. Indicate conformance with the reference standard applicable to the material.

3.11.5.3. For bitumens in hot bulk and truckloads of aggregate delivered to the site in quantity, obtain a certification for each shipment.

3.11.5.4. Store and handle all materials, except bitumen, metal components, and material in sealed cans, as follows:

3.11.5.4.1. Aggregate shall comply with moisture and dust content requirements of ASTM D1863.

3.11.5.4.2. Other materials:

3.11.5.4.2.1. Do not expose materials to water (rain, snow and so forth) before, during, or after delivery to the site.

3.11.5.4.2.2. Completely cover materials with waterproof canvas tarpaulins to protect from weather and moisture. Arrange covers to prevent condensation from occurring beneath them; do not allow covers to extend onto the ground.

3.11.5.4.2.3. Conspicuously mark unprotected materials and permanently remove these materials from the site.

3.11.5.5. Equip kettles and tankers with automatic thermostatic controls and keep them in working order.

3.11.5.6. Use separate kettles and materials application and transporting equipment for asphalts and coal tar products.

3.11.5.7. Do not use bitumens which have been overheated, heated and held beyond specified storage period, or contaminated bitumens. Permanently remove such bitumens from the site.

3.11.6. Daily Work Production.

3.11.6.1. Roofing operations shall be coordinated with sheet metal work so that flashings are installed to permit continuous roof surfacing operations the same day felts are installed where practical. If gravel stops or perimeter flashings are not installed on the same day as roof completion, the roof membrane at perimeters shall be nailed with large-headed nails 8 inches on-center to perimeter wood nailers and sealed against water entry with glass fabric set in roofing cement. Roofing operations shall be coordinated with roof insulation work so that all insulation applied each day is waterproofed the same day with the complete roofing system.

3.11.6.2. Install temporary water cutoffs and tie-ins each workday. Remove temporary cutoffs and tie-ins so that all vertical faces of insulation are exposed at the beginning of the next day's work. (Work Item #4)

3.11.6.3. Do not cut the staggered insulation pieces that are already installed. Straighten the staggered insulation side of the day's work with unattached cut pieces of insulation; do not permanently include such cut pieces into the roof system.

3.11.7. Weather Considerations. Except for expedient temporary work, do not proceed with roofing work during inclement weather. Remove all temporary work before installing permanent components and materials. (Work Item #5)

3.11.8. Followup Inspection. (To be conducted daily to assure compliance with results of initial inspection.)

3.11.8.1. Check items mentioned in preparatory and initial inspections.

3.11.8.2. A copy of these records and contractor tests, as well as the corrective action taken, shall be furnished to the Air Force as directed by the contracting officer.

3.12. WARRANTY SIGN: Provide 10 inch X 12 inch minimum size painted signs (see example) made of aluminum with a dark color background and letters of contrasting color. Use paint compatible with the aluminum. Sign shall read as indicated. Permanently post signs at all access points leading to the roofs and prominent points on the roofs. Provide at least one sign on each roof with at least four signs on each building (located where indicated on the drawing or as directed by the contracting officer).

3.13. NON-DESTRUCTIVE TESTING. The Air Force reserves the right to perform non-destructive evaluation (NDE) of the in-place roofing assembly to determine whether or not the newly installed roofing assembly has been affected by moisture infiltration. Testing shall be at Air Force expense. The contractor is encouraged to be present during the time of NDE.

Part Four - QUALITY CONTROL PROCEDURES

Section A - Instructions for Completing AF Form 1063, Quality Control Record

GENERAL. An example of a completed AF Form 1063 is included with this specification. The contracting officer shall provide sufficient number of AF Forms 1063 to the contractor to cover the anticipated length of this contract. Contractor quality control personnel must follow Instructions 1 through 5 below when completing the daily record. Pages following discuss and identify Work Items 1 through 14. Contractor quality control personnel shall review the work items daily and designate on the Daily Record Form compliance or noncompliance with them. All variances must be explained to the satisfaction of the contracting officer. The following are instructions for filling out AF Form 1063:

1. TOP SECTION:

- a. Insert date and record number.
- b. Insert weather description and temperature.
- c. Indicate crew start and stop times.
- d. Indicate your start and stop times.
- e. Indicate total roof area.
- f. Indicate roof area previously completed.

2. PRODUCTS SECTION. This section is divided into major Categories. Each category may include several materials:

a. Examine each material within the category and check the proper box.

b. Check the "Not Applicable" box for materials not included in today's work.

c. Assure that all materials in a category comply with the contract to result in a check in the "Complies" box. To determine compliance, compare the material with the project specifications and drawings, and also with the approved manufacturer's literature submitted. Since materials other than those covered by the components listed may be used, enter their compliance in the "All Other Materials" category.

3. EXECUTION SECTION:

a. The work item numbers in this section of the record correspond to the work items in these basic QC requirements. The work items are specification items considered to be of major concern. These items are in the basic QC requirements for convenience and tabulation.

b. Performance of the "actions" below the work item will result in an entry in the proper box on the QC record. Specification items not in the basic QC requirements must also be considered, and their acceptability grouped and documented in the "Other" box.

4. VARIANCE SECTION:

a. An entry in any "Varies" box under the "Products" or "Execution" sections requires an explanation of the variance in this section. The explanation should be limited to a description of the variance only. Reasons for variance are not necessary.

b. Indicate action taken to resolve each variance to result in complying work. Certain actions resulting from variances from some of the specification requirements are included with the specified requirement. If a variance is not resolved on the same day it occurs, the number of that day's record must be entered in the space provided on records for all succeeding days, until the variance is resolved.

5. CLOSING SECTION. Sign the record at the end of the workday and submit it to the Air Force inspector.

Section B - Work Items

WORK I T E M I N D E X

WORK I T E M N R. AAAAAAAAAAAAA	D E S C R I P T I O N AAAAAAAAAAAAA
1	M A T E R I A L M O I S T U R E C O N T E N T
2	B I T U M E N T E M P E R A T U R E
3	M A T E R I A L I D E N T I F I C A T I O N / H A N D L I N G
4	W E A T H E R I N G - I N O F D A Y S W O R K
5	I N C L E M E N T W E A T H E R
6	P R O T E C T I N G C O M P L E T E D W O R K
7	S U B S T R A T E P R E P A R A T I O N
8	I N S U L A T I O N I N S T A L L A T I O N
9	P L Y C O N S T R U C T I O N
10	I N T E R P L Y B I T U M E N I N T E G R I T Y
11	S A M P L E R E M O V A L A N D R E P A I R
12	E N V E L O P E S A N D B I T U M E N D A M S
13	F L A S H I N G I N S T A L L A T I O N
14	S U R F A C I N G

W O R K I T E M S

 S p e c i f i e r : N o t e . D e l e t e W o r k I t e m s t h a t d o n o t a p p l y t o t h e
 p r o j e c t a n d r e n u m b e r . A d d W o r k I t e m s a s r e q u i r e d b y p r o j e c t .

(Work Item numbers correspond to Work Items under Execution on AF Form 1063).

W O R K I T E M 1, M A T E R I A L M O I S T U R E C O N T E N T

Do not expose materials to moisture before, during, or after delivery to the site.

Do not apply BURS components if moisture in any form can be seen or felt on the substrate to which the components will be applied.

Action

Inspect materials upon delivery for intact manufacturer's shipping containers.

Verify that the vehicle delivering materials has provided protection of the materials. The vehicle must be enclosed or materials must be completely covered with tarps.

Inspect materials before acceptance for evidence of contact with moisture (such as felt wrappers that are wet or stained, insulation with torn or missing transit covers, or other evidence of moisture by feel or sight).

Inspect storage at the job site. Be sure enclosed storage or other storage completely protects material from moisture in any form.

Observe material handling from storage area to roof. Total protection is required and must be immediately available in case of inclement weather. Delivery to the job site requires the same attention as delivery to the storage area.

Mark conspicuously all materials exposed to any form of moisture and have them permanently removed from the project site.

Make sure components are not applied if the hot bitumen steams, foams or bubbles.

Inspect application of bitumen to felts for similar evidence that shows moisture in felts.

Inspect application of aggregate into flood coat for similar evidence that would indicate wet aggregate.

Air Force Audit Procedures

Observe the mopping procedure. If the bitumen is frothing (foaming) at point of application, further investigate for wet materials.

Use a Delmhorst Model BD-7 moisture meter with 2E and 21E probes or approved equal to check moisture content of materials on the roof, insulation and felts. Assure that the moisture meter is set properly for the material being checked. For the Delmhorst moisture meter the following settings and reading apply:

Material AAAAAAA	Setting AAAAAAA	Reading AAAAAAA
Insulation	20	Less than 15 acceptable
Felts	30	Any reading unacceptable

Check the edges and middle of the material. The edges and first 4 to 6 feet of a felt roll may be wet if improperly stored. Edges of insulation may also be wet if improperly stored.

Materials that have been stored in the sun may give erroneously high moisture readings. When moisture content is questionable, have the contractor hot mop to a sample piece of material. If the material does not foam or froth, use it.

If moisture content of materials is questionable, send a sample in a sealed plastic bag to a government approved laboratory for analysis. Do not use questionable materials until laboratory results are final. Do not use the moisture meter to measure the moisture content of a completed membrane. If use of wet materials is suspect in a particular area of construction, cut a sample and inspect for moisture on the job site.

If materials look wet, smell wet and moisture tests wet, don't use them.

WORK ITEM 2, BITUMEN TEMPERATURE

Equip kettles and tankers for bitumen with automatic thermostatic controls. Post the EVT and flashpoint temperatures conspicuously on each piece of equipment that will hold hot bitumen during roofing operations. Make sure the contractor has an EVT measuring device on the job site in working order and checks and records the EVT temperature at the point of application hourly.

Action

Periodically check the accuracy of the thermostatic controls by using a portable thermometer. Periodically check bitumen temperature within tanker or kettle and at the point of application (EVT).

Air Force Audit Procedures

Using a portable thermometer check the bitumen temperature in the tanker or kettle and at the point of application. Kettle temperature should be no higher than 50 degrees (F) less than the flash point of the bitumen. The temperature at point of application should be within 25 degrees (F) of the EVT of the bitumen.

WORK ITEM 3, MATERIAL IDENTIFICATION/HANDLING

Use separate kettles, materials, application and transporting equipment for coal tar and asphalt products.

Apply membrane to meet requirements and recommendations of the BURS manufacturer.

Action

Inspect equipment upon arrival at job site for condition and identification of previous use. Maintain identification of use throughout the project.

Observe the bitumen handling at the kettles and on the roof to make sure that asphalt felts are being placed in asphalt bitumen and that coal tar compatible felts are being placed in coal tar bitumen.

Make sure the proper type bitumen is being used for roof slope by checking the slope of the roof in the field as well as on the drawings. Review manufacturer and contract specifications for material and installation requirements and compare them with those being used.

Air Force Audit Procedures

Obtain equipment identification information from the Quality Controller. If material variation is expected take a sample of the bitumens in each piece of equipment and send them to a government approved laboratory for analysis of the following: ASTM D312 - asphalt type, ASTM D36 - softening point, ASTM D5 - penetration; ASTM D450 - coal tar bitumen type, ASTM D36 softening point, ASTM D92 - flash point, ASTM D95 - water content. Laboratory results will verify that the proper type of bitumen is being used and that materials are not contaminated.

If material variation is expected after the membrane system is assembled, take a 12-inch X 12-inch roof sample from the completed membrane assembly, prior to surfacing or material samples as required. Send to a government approved laboratory for generic identification of materials.

WORK ITEM 4, WEATHERING-IN OF DAYS WORK

Where practical execute the work so that each area of the BURS installation is completed on the same day it is begun. All bituminous and metal flashings and all related parts necessary to complete the assembly should be completed with exception of the surfacing. If gravel stops or perimeter flashings are not installed on the same day as roof completion, the roof membrane at perimeters shall be nailed with large head nails approximately 12 inches on-center to perimeter wood nailers and sealed against water entry with glass fabric set in roofing cement; or, with 20 mil vinyl nailed through membrane to perimeter wood nailers.

Install temporary water cutoffs and tie-ins at the end of each workday. Remove temporary cutoffs and tie-ins on resuming work so that all vertical faces of insulation are exposed.

Action

Determine area of work planned and make sure that enough materials are on hand to complete that area.

Inspect work completed at day's end.

Confirm completion to include final roof surfacing, where practical, on all material installed except the area required for tie-in of future work. The tie-in area is glaze-coated with bitumen.

Observe tie-in to verify that insulation joints are staggered and ply structure is continued.

Confirm removal of temporary work and check previously installed system for moisture.

Air Force Audit Procedures

Compute the number of squares of unused insulation on the job. Compare with contractor's previous days work performance. Question shortage or excess materials required for a day's work.

Periodically perform daily audit at the close or beginning of the work day to visually inspect watertightness of temporary water cutoffs.

WORK ITEM 5, INCLEMENT WEATHER

Except for expedient temporary work, do not proceed with roofing work during inclement weather.

Action

During bad weather, make sure that work being performed is only temporary and protects the facility and previously completed roofing system.

Make sure all temporary work is removed before installation of permanent components when work is resumed.

Air Force Audit Procedures

Check job site to ensure that roofing is not being installed during inclement weather. Make sure all previously constructed work is weathered-in properly. Conspicuously mark any insulation or felts left on the job site and not properly protected from the elements. When the weather breaks, be sure these materials are removed from the job site and not used in future roof construction.

WORK ITEM 6, PROTECTING COMPLETED WORK

Do not load or permit any part of a structure to be loaded with a weight that will adversely affect its safety.

If wheeled or other traffic over the partially or fully completed roofing is unavoidable, provide and use adequate plank or plywood protection for the roofing.

Action

Inspect activities and methods used to transport materials over the completed or partially completed roofing system.

Check adequacy of plank or plywood to protect system.

Make sure runways (such as wood planks or plywood) are used to distribute the load of materials and equipment hauling over the deck so as not to cause deflection of the deck. Check for broken welds or bends in metal decking due to materials or equipment handling.

Air Force Audit Procedures

Periodically lift the plank or plywood used to protect the roofing system. Check the membrane at this location for puncture or other surface damage.

After the weight is removed from a suspect overload area, walk the area and check for soft or depressed areas. Check soft areas from under side of deck for structural damage. Lay straight edge across suspected depressed areas to verify presence of a depression and possible future ponded area.

WORK ITEM 7, SUBSTRATE PREPARATION

Removal of existing materials must result in a clean and dry substrate, except for residual stains, providing a surface suitable to apply new materials.

Action

Inspect substrate for excessive roughness, cracks, holes, or deteriorated material.

Make sure decking or other substrate determined to be defective is repaired, replaced, or brought to the attention of the contracting officer.

Make sure deck joints are treated to prevent bitumen drippage through the joints.

Air Force Audit Procedures

Periodically check the substrate before the roof system is installed to be sure it is clean and dry.

WORK ITEM 8, INSULATION INSTALLATION

Make sure insulation boards, cant strips and tapered edge strips are adequately secured and spaced.

For insulation boards on steel deck, first (bottom) layer; position insulation so that side joints between boards do not occur over deck rib opening. Stagger end joints. Secure insulation boards to the metal deck with approved mechanical fasteners according to insulation manufacturer, FM and UL requirements.

Second or additional layers, cant strips and tapered edge strips; secure in full and uniform moppings of hot fluid bitumen, stagger end joints, bring boards into moderate, uniform contact at sides and ends and press insulation boards firmly into the bitumen while the bitumen is hot and fluid. Offset all joints between layers in both directions.

Action

Make sure the first layer of insulation is fully secured to the substrate in the specified manner according to FM I-90.

Measure the distance from the inner row of fasteners to the perimeter. Count and locate fasteners with respect to insulation board.

Test bond of insulation boards, cant strips, and tapered edge strips by trying to lift them after installation. Materials that are readily lifted without breaking the board or strip are not securely fastened.

Observe application of asphalt by machine; be sure jets are flowing evenly and consistently. Application rate must be controlled to the rate specified by the manufacturer.

Make sure long edges of insulation are parallel to and supported by the flanges and that joints do not occur over a rib opening.

Make sure staggered pattern of insulation joints is begun at start of placement and develop a pattern to establish the joints at one-half the length of a full piece of insulation board. Measure joints that are not in contact to assure that the gap is less than the 3/16-inch requirement.

Make sure contact at sides and ends of board is obtained when insulation boards are placed in hot and fluid bitumen.

Make sure insulation covers entire area of deck to within 1/4 inch of vertical surfaces and wood insulation stops. Test bond of insulation boards, cant strips and tapered edge strips by trying to lift them after installation. Materials that are readily lifted without breaking are not securely fastened.

Air Force Audit Procedures

Spot check the gap between insulation boards. Maximum allowable is 3/16 inch.

When mechanical fasteners are used check all installed boards that have not been covered with the second layer of insulation for the proper number of fasteners and spacing.

Spot check bond of mopped in place insulation boards, cant strips and tapered edge strips by trying to lift them.

Check the end of the first layer insulation run to make sure boards are not butted over and are parallel to the steel deck ribs where applicable and end laps are staggered by a minimum of 6 inches. Check the end of the second layer of insulation to ensure that end joints are offset by maximum dimensions.

Fasteners. Look for overdriven or underdriven fasteners, overdrilled holes, fasteners driven at angles, and fasteners driven too close to the edge of the insulation board (minimum 6 inches from board edge). Check underside of deck to ensure that fasteners are penetrating the deck, when required. On steel decks, examine underside to make sure fasteners are engaging a point at or near the middle of the top flange. (It may be necessary to snap a chalkline on the insulation over the flange centers.)

WORK ITEM 9, PLY CONSTRUCTION

Apply felts shingle fashion and keep proper lap distance to result in a 1-inch minimum. Maintain a straight run of felts so that kinks or fishmouths do not result, and the felts are completely flat.

Once established, do not change the direction of felt application.

Action

Make sure felts are rolled true to premarked lines on felts or chalklines.

Immediately upon deviating from the felt line, make sure the roll of felt is cut and restarted with specified endlap. Do not allow roll to be forced back on line without cutting.

Make sure fishmouths or kinks do not appear at the felt edges due to a run of felts other than in a straight line. Cut and patch these discrepancies as they occur or by the end of each days work.

Make sure no foreign particles (aggregate, etc.) are sealed between plies.

Measure lap exposure (the distance between two exposed adjacent edges) and compare this to the required felt line distances. These distances must be equal.

Make sure the ply lines are parallel for entire roof area and that the direction of felt application is not changed.

Air Force Audit Procedures

Spot check the distance between adjacent plies for accuracy.

Spot check the distance across four plies for accuracy. Keep in mind that the minimum acceptable head lap is 1 inch.

Walk completed ply construction that has not been surface coated. Check for fishmouths and kinks.

Check felt application versus roof slope to assure that felt edges do not oppose the flow of water.

WORK ITEM 10, INTERPLY BITUMEN INTEGRITY

Broom or squeegee each ply of roll goods into place, full width, while the bitumen is hot and fluid, so that felt does not touch felt and the bitumen layer does not have voids or skips. Do not walk on felts until bitumen is "set".

Description of Voids:

a. Glazed Void: A bubble within the interply layer that is completely encapsulated in bitumen. A maximum of 5 percent (7.2 sq inches) surface measure is permitted in any one interply layer.

b. Uncoated Void: A bubble within the interply layer that is not completely encapsulated, but exposed to the roofing felt on one surface. Uncoated voids are not acceptable.

c. Dry Void: A bubble within the interply layer that is not encapsulated, but is exposed to the roofing felt on both surfaces. Any dry voids are unacceptable.

d. Voids that overlay in two or more adjacent interply layers are not acceptable.

Action

Periodically during the day, check the temperature of the bitumen at the point of application.

Each ply of the rolled felts must be pressed in place with a broom or squeegee the full width of the roll. Confirm that brooming or squeegeeing is adequate to embed the felts into the bitumen and to make sure that bitumen is between all surface areas of the felts, including the edges. Asphalt must be continuously visible along each edge of the sheet.

Do not permit walking over felts until bitumen is cooled to set temperature. Refer to NRCA Publication, Application Techniques for Glass Fiber Roofing Felts, as a recommended application procedure.

Air Force Audit Procedures

At the beginning of a job, cut a 12-inch x 12-inch sample daily from each crew's work. Cut samples accurately using a template. Continue this daily sampling process until each work crew consistently meets stated tolerances on interply bitumen weight, head laps, and void content. Samples to be analyzed IAW ASTM D-3617. Thereafter, cut samples only when one of the following occurs:

Climate conditions such as wind, temperature, humidity, changes significantly from when the last sample was taken.

Crew members change, or their job on the crew changes.

Visual observations indicate non-standard construction techniques such as walking on freshly laid felts, not brooming full width of felts, and so forth.

EVT out of tolerance.

Continuous bitumen film not present at edge of felts.

Equipment malfunction.

At the beginning of the job, weigh 5 to 10 rolls of felt. Calculate the average weight per roll in pounds per square (see attached Sample Analysis Worksheet behind this attachment). This information is needed to calculate average mopping weights on the Sample Analysis Worksheet.

Cut the sample perpendicular to the plies starting at a ply lap edge. Cut the sample from the completed membrane assembly before any surfacing is applied.

Weigh the sample in grams. Measure the head laps and overall size of the sample. Freeze the sample. Split the plies apart. (Note: If the plies do not split apart easily, you may have to fracture the interply bitumen by tapping the sample with a wood mallet or similar blunt object. This will not disturb the void pattern. Using a clear grid template, lay the sample out and measure the air voids, and areas where no bitumen exist (felt-on-felt). Record all information on an appropriate form. Examine the sample with the Quality Controller and the Job Foreman. Compare the sample against acceptable tolerances. Discuss any variances, determine probable cause and make immediate adjustments in the construction process to preclude recurrence. The intent of the membrane sampling and on-the-job analysis and feed back is to improve the overall quality of the BUR construction. A single occurrence of variance does not necessarily mean that the construction is unacceptable. But, do not proceed with further construction unless the cause of the out-of-tolerance condition can be adjusted to provide acceptable construction thereafter.

If samples are unacceptable, some recommended adjustments are as follows: Improve brooming of the felts to minimize air voids; a series of small pin holes indicates moisture in the felts - check materials; On windy days follow closely behind felt layer with brooming to minimize premature bitumen cooling and voids; closely monitor EVT and tanker bitumen temperature.

WORK ITEM 11, SAMPLE REMOVAL AND REPAIR

The contractor must remove samples and repair the area of sample removal. Samples to be cut and analyzed IAW ASTM D-3617.

Action

Witness removal of test samples required by the project specification.

Visually examine sample components for adhesion to each other, edge voids and presence of moisture. Record observations of defects on AF Form 1063.

Direct and observe repair of sample area.

Do not leave the sample on the roof or in the sun. Remove the sample from the roof immediately and evaluate for compliance with the Air Force Inspector.

Air Force Audit Procedures

Select the location and size of all samples to be cut from the membrane and evaluate the sample for compliance.

Inspect all sample repair areas for water tightness.

WORK ITEM 12, ENVELOPES AND BITUMEN DAMS

Provide organic felt envelopes, or other approved methods, at gravel stop roof edges, and at deck penetrations to stop bitumen drippage.

Action

Before the start of felt application, assure that a organic felt strip, at least 18 inches wide, is set in steep asphalt or flashing cement and is applied so that half width is set on the nailer around perimeter of building and half width is lapped over the edge of the building.

After felt application is complete, make sure the overlapped section of felt is folded back over the BUR and mopped down to form an envelope around the edge of the roof membrane.

Make sure at all penetrations, a felt envelope or other positive means of preventing bitumen drippage is installed.

Make sure flanges of metal are primed before installation into system.

Air Force Audit Procedures

At the beginning of the job, verify that an organic felt envelope has been installed at all roof edges and that a positive means of preventing bitumen drippage is installed at all roof penetrations.

WORK ITEM 13, FLASHING INSTALLATION

Flashing system according to BURS manufacturer's requirements.

Action

Make sure proper materials are being applied and that materials are the products of the BURS manufacturer as recommended for 20-year warranted system over the substrate involved.

Before start of flashing application, assure that roofing felts extend to top of cant strips.

Make sure all vertical surfaces are primed before receiving flashing. The primer must be dry before applying the flashing.

Check for flashing bond to all areas of contact and for overlap of all end joints.

Make sure end joints between layers of flashing do not coincide during application.

Air Force Audit Procedures

Obtain a copy of the BURS manufacturer's requirements from the Quality Controller. Periodically check for compliance of materials and installation procedure.

Check all installed flashings for compliance with drawings.

WORK ITEM 14, SURFACING

The surface shall be flood-coated uniformly and aggregate surfacing applied according to BURS manufacturer requirements and specifications.

Action

The surface shall be broom cleaned and free from moisture.

Aggregate surfacing shall be clean and dry, and meet specifications requirements.

Air Force Audit Procedures

Use MIL gauge to check flood coat film thickness. Note: Two MILS film thickness is approximately equal to one pound of bitumen per square. Check film thickness while flood coat is hot.

Send a sample of the aggregate to a government approved laboratory for gradation analysis.

Broom away loose aggregate from a one-foot-square area. Estimate amount of embedded aggregate coverage.

(THIS PAGE IS BLANK)

SUBMITTAL #1

BUILT-UP ROOFING (BUR) MANUFACTURER
PRE-AWARD CERTIFICATION SUBMITTAL

The following statement is required from the BUR manufacturer. The BUR manufacturer is defined as the roof membrane product manufacturer who may or may not manufacture the other system components, such as metal or other flashings, insulation, and fasteners.

This is to advise that _____ (roofing contractor/subcontractor) is an approved applicator of our roofing system and is capable of obtaining our 20-year labor and materials warranty/guaranty. We will execute the 20-year BUR warranty/guaranty certification upon the successful completion of all work in accordance with the project plans and specifications or as modified to comply with our 20 year roofing system requirements, which ever is most stringent.

We have reviewed the System Summary Sheet for Project No. _____ at _____ (location). We certify that the built-up roofing systems listed below and described in the attached product literature are suitable for use with the roof system construction specified for this project as it relates to normal wear and exposure to the elements.

We certify that the specified insulations are compatible with the membrane and would qualify for our 20 year materials and labor warranty/guaranty. We accept responsibility for defects or failure of, or improper application of, roof insulation used as a base over which the roofing is applied, except the roof deck. This warranty applies only to total tear-off and replacement.

We understand that proposed changes relating to the roofing system will be submitted for our review and acceptance. A signed copy approving the concept of the change will be returned to the Contracting Officer.

Building Number(s)	(Membrane)	Roofing System Designation *	(Insulation)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

A technical representative can be made available to attend the pre-construction conference to discuss proper installation procedures for our BUR system. A technical representative will also be available to make at least one in-progress inspection and one final acceptance inspection of the BUR installation.

Roofing Manufacturer

Firm Name: _____

Address: _____

Authorized Representative

Signature: _____

Printed or Typed Name: _____

Signed This _____ Day of _____ 19 ____

* 2 Atch
1. BUR System Literature
2. Insulation Manufacturer's Literature

Atch 1-1

SUBMITTAL #2

SYSTEM SUMMARY SHEET

(To be completed and signed by an approved roofing contractor and BURS manufacturer prior to contract award.)

This is to notify you that we shall apply your full 20 year labor and materials warranty/guaranty to the following project.

Solicitation No. _____

Name of Job _____ Name of Building _____

Address of Building: Street _____ City _____ State _____ Zip _____

Type and Use of Building _____

Owner of Building _____

Address: Street _____ City _____ State _____ Zip _____

☐ New Building ☐ Recover ☐ Tear Off

No of Squares _____ Mfg Spec # _____ No. of Feet of Flashing _____ Mfg Spec # _____

Description of Project: _____

Roof Slope: _____ Does the Roof have adequate drainage? ☐ Yes ☐ No

Deck: ☐ Steel Gauge _____ Joist Spacing _____ Width of Rib _____

☐ Wood Type _____ Thickness _____ Joist Spacing _____

☐ Lightweight Concrete Type _____ Min. Thickness _____

☐ Concrete Type _____ ☐ Structural Wood Fiber Trade Name _____

☐ Gypsum Type _____ ☐ Other (Specify) _____

Vapor Retarder: ☐ No ☐ Yes ☐ Old ☐ New Type _____

New Insulation: ☐ Fiberboard ☐ Perlite ☐ Isocyanurate ☐ Other _____

☐ EPS ☐ Urethane ☐ Cellular Glass ☐ Fiberglass ☐ Phenolic

Attachment ☐ Mechanical Fastener Type _____

☐ Hot Asphalt

Insulation Manufacturer _____ No. of Layers _____ Thickness _____

Recover Info: Number of Existing Roofs? _____ Existing Surface? ☐ Smooth ☐ Gravel ☐ Cap Sheet

Loose Gravel to be Removed? ☐ Yes ☐ No Wet Insulation? ☐ Yes ☐ No

Waterlogged areas to be removed? ☐ Yes ☐ No

Roof Vents to be used? ☐ Yes ☐ No Spacing _____

This job will be completed in accordance with the contract specifications or the latest issue of the BURS manufacturer "Commercial Roofing Specifications" manual, which ever is most stringent, and we will use only the undersigned manufacturer's products unless other products are approved by the BURS manufacturer.

We plan to start this job on _____ We plan to complete the job on _____

Name of Roofing Contractor/Subcontractor: _____ Phone No. _____

Address: _____

Signature of Company Official _____ Title _____ Print Name _____

We acknowledge your notification that the U.S. Government 20-year BURS Warranty/Guaranty will be required on the roof described above and will sign and issue this warranty/guaranty to the government upon your successful completion of this project. There will be a charge to you of \$ _____

Manufacturer: _____

Authorized Representatives: _____ Date: _____

SUBMITTAL 3

APPOINTMENT OF QUALITY CONTROLLER

_____ (Name) is appointed as quality controller on Project _____ with the authority to regulate the quality of the work so that it conforms to the contract. The quality controller is authorized to order discontinuance of any operation causing nonconforming work.

The quality controller is experienced in the supervision and inspection of BURS construction similar to that required in this contract. The quality controller understands all requirements of these specifications.

Name of Firm _____

Address _____

Telephone _____

Authorized Representative's Signature _____

Printed or Typed Name _____

Date _____

I acknowledge receipt of this letter.

Quality Controller's Signature _____

Printed or Typed Name _____

Date _____

SUBMITTAL 3

APPOINTMENT OF QUALITY CONTROLLER

_____ (Name) is appointed as quality controller on Project _____ with the authority to regulate the quality of the work so that it conforms to the contract. The quality controller is authorized to order discontinuance of any operation causing nonconforming work.

The quality controller is experienced in the supervision and inspection of BURS construction similar to that required in this contract. The quality controller understands all requirements of these specifications.

Name of Firm _____

Address _____

Telephone _____

Authorized Representative's Signature _____

Printed or Typed Name _____

Date _____

I acknowledge receipt of this letter.

Quality Controller's Signature _____

Printed or Typed Name _____

Date _____

SUBMITTAL #4
BUILT-UP ROOFING (BUR) SYSTEM
20-YEAR LABOR AND MATERIAL WARRANTY/GUARANTY

WARRANTY COVERAGE:

This system is delivered subject to a full material and workmanship warranty/guaranty for 20 years that guarantees that the manufacturer will pay all costs necessary to maintain the built-up roofing membrane and flashing system in a water-tight condition as a result of the following causes: deterioration from ordinary wear and tear of the elements; poor workmanship on the part of the contractor; defects in materials; defects in the manufacturer's specifications; blisters, bare spots, fishmouths, wrinkles or ridges in the built-up roof; and splits in the built-up roof membrane caused by movement of the roof insulation or any other underlying surface, or material used as a base over which the roof system is applied, excluding the deck. Specific conditions that will affect warranty/guaranty coverage and exclusions from coverage are not covered by this warranty/guaranty.

The specified roof system is our 20-year system design and the insulations specified are compatible with our materials. As the manufacturer of this system, we also accept responsibility for making repairs to the roofing system at no additional cost to the government, to correct defects in, failure of, or improper application of, roof insulation used as a base over which the roof is applied, except the roof deck.

If the manufacturer fails to make required emergency and permanent repairs during the warranty/guaranty period, as stated after notice by telephone from the contracting office, the government may have the work done by others and charge the cost to the manufacturer. The warranty provisions of this contract apply notwithstanding government inspection and acceptance. A separate warranty/guaranty is required for each building. Failure to perform the work resulting in the government having the work performed will not void this warranty/guaranty.

TERMS, CONDITIONS, LIMITATIONS:

Emergency repairs shall be made within 48 hours of receipt of notice by telephone from the contracting officer and weather permitting, the manufacturer agrees to permanently repair the affected areas within 30 days by restoring them to a water-tight condition, without cost to the government. If it is determined that leaks were caused by either an exclusion from coverage or a specific condition listed below, the manufacturer will repair the defects and an equitable payment will be made by the government.

EXCLUSIONS FROM COVERAGE:

1. Natural disasters, acts of God (lightning, hurricanes, tornadoes, sustained winds exceeding 75 MPH as recorded at the nearest meteorological center, earthquakes, hail).
2. Acts of negligence or abuse and misuse by government personnel, accidents, vandalism, civil disobedience, war, or damage caused by falling objects.
3. Damage by structural failure, settlement, movement, distortion, warpage, or displacement of structure.
4. Failure of material or flashings caused by movement of metal work not supplied by manufacturer issuing warranty/guarantee.
5. Leaks caused by repairs or alterations of roof system or installation of structures, fixtures or utilities on or through roof without prior written approval of manufacturer.
6. Storage of material on roof.
7. Moisture entering roof system through walls, copings, or any part of building structure except the roof, including from adjacent building.
8. Fire.
9. Faulty construction or design of building, including parapet walls, copings, chimneys, skylights, vents, or of roof deck but specifically excluding construction above the deck, i.e., insulation, base sheet, fasteners, adhesive, vapor retarders, and so forth.
10. Infiltration or condensation of moisture in or through underlying area; vapor condensation beneath the roof greater than the acceptable ambient moisture content for the given material as established by the appropriate American Society for Testing and Materials (ASTM) standard in effect at the time of installation.
11. Damage or leaks attributable to ponding water, defined as water in ponded areas that does not drain or evaporate within a 48 hour period.
12. Under no circumstances is the manufacturer responsible for damages to the building, its contents or roof deck.
13. Membrane splits caused by structural movement.

SPECIFIC CONDITIONS THAT WILL AFFECT WARRANTY/GUARANTY COVERAGE:

1. Failure to use reasonable care in maintenance; failure to follow manufacturer's written maintenance instructions.

2. Failure of owner to make repairs to leaks not covered by manufacturer's warranty/guaranty.
3. Repair work by any contractor other than BUR manufacturer approved contractor or use of unapproved material.
4. Changes in building usage which may affect roof performance unless approved in writing by the BUR manufacturer prior to such change.

DETERMINATION OF RESPONSIBILITY:

Receipt of notice by telephone or in writing from the contracting officer is evidence that the contracting officer has had the roof examined by a technically qualified representative of the government and has determined, based on this examination, that none of the above causes apply and the manufacturer is obligated to make the repairs.

Within 30 days of receipt of the above notice by the manufacturer that a roofing system defect covered by the warranty/guaranty has been discovered, the manufacturer, to avoid application of the warranty/guaranty, must notify the contracting officer in writing of the existence of an exclusion stated herein. Failure to provide such notice will preclude the manufacturer from later disputing the coverage of the warranty/guaranty.

The government has the right to perform both visual and nondestructive evaluations of the roof system, at government expense, any time during the warranty/guaranty period to validate water tightness of the roof system.

After the occurrence of an exclusion from coverage or a specific condition which renders the warranty/guaranty ineffective, the warranty/guaranty shall be allowed to continue as long as the government returns the roofing system to its original condition and the manufacturer is allowed to inspect or oversee the repair. The burden to establish the existence of an exclusion or specific condition is on the manufacturer.

The 20-year coverage period starts from the date the facility or roofing system is accepted by the government from the contractor.

BENEFICIARY

It is understood by the manufacturer and contractor that the warranty/guaranty provided herein shall be for the benefit of the United States government.

BURDEN OF PROOF

The manufacturer shall have the burden of proving by a preponderance of the evidence the existence of a condition which established an exclusion from coverage, or which would render the warranty/guaranty ineffective or null and void.

OTHER WARRANTIES

The warranty contemplated herein shall be in addition to and not in lieu of any warranty/guaranty otherwise applicable to the work or materials used in the contract.

SIGNATURE:

BURS Manufacturer Firm Name _____

Address _____

Authorized Representative's Signature _____

Date _____

Authorized Representative's Name _____

(Print or Type)
Title _____

Manufacturer's Warranty/Serial Number _____ for Building Number _____ located

at _____

Warranty/Guaranty expiration date _____

1 Atch
BURS Manufacturer
Specification, Description
and Recommendation

**DO NOT MAKE
REPAIRS OR ALTERATIONS
TO THIS ROOF**

**WITHOUT APPROVAL
FROM THE
BASE CIVIL ENGINEER**

**THIS ROOF IS UNDER WARRANTY UNTIL (1) BY
MANUFACTURER (2)**

**ADDRESS
CITY, STATE, ZIP CODE
PHONE: AREA CODE / NUMBER**

SIGNS - TO BE POSTED AS SPECIFIED

- (1) INSERT WARRANTY EXPIRATION DATE (20 YEARS FROM FINAL ACCEPTANCE).
- (2) INSERT THE MANUFACTURER'S NAME, ADDRESS, AND PHONE NUMBER.

QUALITY CONTROL RECORD					RECORD NO. <u>10</u>		DATE <u>31 Mar 89</u>	
PROJECT NUMBER <u>OFF 87-0050</u>			BLDG NO. <u>300</u>		ROOFING CREW		QUALITY CONTROLLER	
WEATHER (Describe) <u>Sunny & Hot</u>			AVERAGE TEMPERATURE <u>91°</u>		START <u>7:30</u> AM		START <u>7:30</u> AM	
					STOP <u>4:30</u> PM		STOP <u>4:30</u> PM	
TOTAL ROOF AREA (Squares) <u>1000</u>		PREVIOUSLY COMPLETED <u>350 Sqs</u>		COMPLETED TODAY <u>35 Sqs</u>		TEST SAMPLES REMOVED <u>1</u>		
PRODUCTS (See Project Specifications) (Check Appropriate Box Below)					EXECUTION (See Quality Control Guide) (Check Appropriate Box Below)			
COMPONENTS (Type, Quantity, Size)	COM- PLIES	VARIES	NOT APPLI- CABLE	WORK ITEM	COM- PLIES	VARIES	NOT APPLI- CABLE	WORK ITEM
UNDERLAYMENT			✓	1	✓			13
INSULATION	✓			2	✓			14
MEMBRANE	✓			3	✓			15
COMPO. FLASHING	✓			4	✓			16
SHEET METAL	✓			5	✓			17
FASTENERS	✓			6	✓			18
WOOD	✓			7	✓			19
SEALANTS	✓			8	✓			20
EXPANSION JOINTS	✓			9	✓			21
ALL OTHER MATERIALS	✓			10	✓			22
				11	✓			23
				12	✓			OTHERS
EXPLAIN VARIANCE (if none write NONE) <div style="text-align: center; font-size: 2em; margin-top: 20px;">None</div>								
UNRESOLVED VARIANCES ON RECORDS NOS. <u>Q.C. Record No. #8</u>								
ACTION TAKEN TO RESOLVE VARIANCE <div style="text-align: center; font-size: 1.2em;">50 Square feet of insulation left on roof over night was removed from job.</div>								
I CERTIFY THAT I HAVE PERSONALLY PERFORMED THE REQUIRED TESTS AND MEASUREMENTS AND ATTEST THAT THIS Q.C. RECORD IS AN ACCURATE RECORD OF ALL WORK ACCOMPLISHED TODAY.								
QUALITY CONTROLLER (Signature): <u>Ron T. Smith</u>								
RECEIVED BY (Signature): <u>Niel R. Roof</u>								
								DATE <u>31 Mar 89</u>

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
82-2	Energy Efficient Equipment	10 Nov 82
83-1	Design of Control Systems for HVAC	16 Feb 83
	Change No. 1 to ETL 83-1, U.S. Air Force Standardized Heating, Ventilating & Air Conditioning (HVAC) Control Systems	22 Jul 87
83-3	Interior Wiring Systems, AFM 88-15, Para 7-3	2 Mar 83
83-4	EMCS Data Transmission Media (DTM) Considerations	3 Apr 83
83-7	Plumbing, AFM 88-8, Chapter 4	30 Aug 83
83-8	Use of Air-to-Air Unitary Heat Pumps	15 Sep 83
83-9	Insulation	14 Nov 83
84-2	Computer Energy Analysis	27 Mar 84
	Change 1 Ref: HQ USAF/LEEEU Msg 031600Z MAY 84	1 Jun 84
84-7	MCP Energy Conservation Investment Program (ECIP)	13 Jun 84
84-10	Air Force Building Construction and the Use of Termiticides	1 Aug 84
86-2	Energy Management and Control Systems (EMCS)	5 Feb 86
86-4	Paints and Protective Coatings	12 May 86
86-5	Fuels Use Criteria for Air Force Construction	22 May 86
86-8	Aqueous Film Forming Foam Waste Discharge Retention and Disposal	4 Jun 86
86-9	Lodging Facility Design Guide	4 Jun 86
86-10	Anti-terrorism Planning and Design Guidance	13 Jun 86
86-12	Prewired Workstations and Systems Furniture	3 Jul 86
86-14	Solar Applications	15 Oct 86
86-16	Direct Digital Control Heating, Ventilation and Air Conditioning Systems	9 Dec 86
87-1	Lead Ban Requirements of Drinking Water	15 Jan 87
87-2	Volatile Organic Compounds	4 Mar 87
87-4	Energy Budget Figures (EBFs) for Facilities in the Military Construction Program	13 Mar 87
87-5	Utility Meters in New and Renovated Facilities	13 Jul 87
87-9	Prewiring	21 Oct 87

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
88-2	Photovoltaic Applications	21 Jan 88
88-3	Design Standards for Critical Facilities	15 Jun 88
88-4	Reliability & Maintainability (R&M) Design Checklist	24 Jun 88
88-5	Cathodic Protection	2 Aug 88
88-6	Heat Distribution Systems Outside of Buildings	1 Aug 88
88-7	TEMPEST & High Altitude Electromagnetic Pulse (HEMP) Protection for Facilities	24 Aug 88
88-8	Chlorofluorocarbon (CFC) Limitation in Heating, Ventilating and Air-Conditioning (HVAC) Systems	4 Oct 88
88-9	Radon Reduction in New Facility Construction	7 Oct 88
88-10	Prewired Workstations Guide Specification	29 Dec 88
89-1	1988 Energy Prices and Discount Factors for Life-Cycle Cost Analysis	6 Feb 89
89-2	Standard Guidelines for Submission of Facility Operating and Maintenance Manuals	23 May 89
89-3	Facility Fire Protection Criteria for Electronic Equipment Installations	9 Jun 89
89-4	Systems Furniture Guide Specification	6 Jul 89
89-5	Air Force Interior Design Policy	not yet
89-6	Power Conditioning and Continuation Interfacing Equipment (PCCIE) in the Military Construction Program (MCP)	7 Sep 89
89-7	Design of Air Force Courtrooms	29 Sep 89
90-1	Built-Up Roof (BUR) Repair/Replacement Guide Specification	23 Jan 90

23 Jan 90

SECTION B - OBSOLETE ETLs

No.	Date	Status
82-1	10 Nov 82	Superseded by ETL 83-10, 86-1, 87-4
82-3	10 Nov 82	Superseded by ETL 83-5, 84-2
82-4	10 Nov 82	Superseded by ETL 84-7
82-5	10 Nov 82	Superseded by ETL 84-1, 86-13, 86-14
82-6	30 Dec 82	Cancel I ed
82-7	30 Nov 82	Cancel I ed
83-2	16 Feb 83	Superseded by ETL 84-3
83-6	24 May 83	Cancel I ed
84-3	21 Mar 84	Cancel I ed
84-4	10 Apr 84	Superseded by ETL 86-7, 86-15, 87-5
84-5	7 May 84	Superseded by ETL 84-8, 86-11, 86-18, 88-6
84-6	Not I ssued	Cancel I ed/Not Used
84-9	5 Jul 84	Superseded by ETL 88-7
86-3	21 Feb 86	Superseded by ETL 86-4
86-6	3 Jun 86	Superseded by ETL 86-11, 86-18, 88-6
86-17	17 Dec 86	Superseded by ETL 89-6
87-3	12 Mar 87	Superseded by ETL 87-6, 88-5
87-7	14 Oct 87	Superseded by ETL 89-1
Change 1	30 Dec 87	Superseded by ETL 89-1
87-8	19 Oct 87	Superseded by ETL 90-1
88-1	05 Jan 88	Superseded by ETL 89-2

SPECIFIER NOTES:

CONTRACT GUIDANCE FOR PREPARING BUILT-UP
DESIGNS, SPECIFICATIONS AND DRAWINGS

1. Introduction. This attachment contains guidance to help you prepare the project documents necessary to procure low-slope roof repair, replacement and new construction by contract. Thorough knowledge of current roofing technology is necessary to prepare and enforce low-slope roof contract documents. A list of references is behind this attachment, for this purpose. If you need technical assistance during the design and construction process, contact your major command roofing engineer.

2. Contract Documents.

a. You will need to gather many facts about the roof and include them in the contract. Below are some types of information you need and how to obtain it.

(1) Cut at least one probe into the roof system of each roof area to determine existing conditions. Probes should extend down through all components to the structural deck. Patch the probe immediately after it is cut.

(2) Use photographs to identify existing conditions on contract drawings. Indicate exact photograph location and orientation on the roof plan.

(3) Measure the location and size of all roof penetrations and equipment.

(4) Plot areas of ponded water and note the reason. This will help in any drainage considerations.

(5) Indicate the downward roof slope direction with an arrow pointing down the slope. Determine the slope and show it on the plan, in inches per foot.

(6) Indicate the north direction, using a compass if necessary. Designate a reference north if desired.

(7) Make sketches of all detail conditions, such as penetrations, curbs, and roof edges. Identify and dimension all components of each detail (include material type, fasteners, and similar information). Indicate if the materials are to be reused. Identify each detail with a letter or number and plot the location on the roof plan. The actual construction seldom appears on record drawings so this step is very important.

(8) Where existing detail conditions appear inadequate or unsatisfactory, sketch possible alternate treatments next to the detail showing the existing conditions. Use standard construction details as a reference.

(9) Where the detail is not apparent, probe as necessary to determine the underlying conditions.

(10) Identify unused equipment and penetrations presently located on the roof. Talk to the building manager to see if you can have unused or unwanted equipment removed. If so, arrange to remove as part of the roofing contract.

(11) Note any building problems such as insufficient clearance for roofing work between the roof and the bottom of equipment. Also, note deteriorations that are not directly related to roofing; for example, metal work that needs painting. If possible, make other needed repairs to the building prior to beginning the contract roof repair. This will allow the new roof to remain undisturbed longer.

b. For new BUR construction use Corps of Engineers Guide Specification Section 7R5, Built-Up Roofing (Air Force only). Use US Air Force, Built-Up Roof Repair/Replacement Guide Specification, for major BUR repair and reroof work. For non-conventional roof construction, major repair and reroof, use the latest available Corps of Engineers guide specification or US Navy Federal Guide Specification.

c. Use National Roofing Contractors Association (NRCA) and Sheet Metal and Air Conditioning Contractors National Association (SMACNA) details as a guide in developing construction details.

d. Each set of drawings for a roofing project must contain the following items as applicable to the project:

(1) A cover sheet with a map of the base with all the buildings included in the contract clearly designated. The base engineering office, contracting office, disposal areas, travel routes and staging areas also may be shown.

(2) A plan view of each building showing:

(a) Roof shapes.

(b) Approximate dimensions.

(c) Direction of roof slope, using arrows pointing down slope.

(d) Magnitude of roof slope, inches per foot, for each level (if dead level, so indicate and leave the arrows off).

(e) The location of all membrane penetrations.

(f) Designated north.

(g) Areas on the same building that have different types of bitumen.

(h) Areas of the roof that will not be reroofed or treated in any way (mark NIC, not in contract).

(i) Areas of the roof that will be repaired only and not reroofed.

(j) Areas of the deck that are expected to need repair or treatment of some kind.

(k) Equipment (indicate which is to be removed).

(l) Roof access locations.

(3) As a rule, elevation drawings of the entire building are not necessary. But the elevation above the ground of all roof levels must be shown. The contractor needs to know the height of the roofs for estimating and equipment planning.

(4) Section details are required for all areas needing flashing. Every type of roof edge, end condition and penetration must have a section detail. Provide a key showing where each section detail applies on the plan view of the roof. Details should be at a scale of 3 inches equal 1 foot. Two separate section details, one for existing and another for new conditions are not usually necessary. All that is required is a section detail showing the new work. But, if you must modify existing conditions, clearly show the existing materials that will remain. Show these materials as "materials to be reused."

(5) The specification covers the items below. You should not refer to them in the drawings:

(a) Felt type.

(b) Bitumen type.

(c) Metal type and gauge.

(d) Insulating layer between dissimilar metals.

(e) Flashing cement.

(f) Material composition designation.

(g) Nail spacing.

(h) Sealant type.

(i) The pattern of nailing gravel stop and fascia edge, and the top of base flashing felts.

e. You should not use a typical NRCA/SMACNA construction detail unless it is compatible with existing conditions. It may be necessary to show some of the existing conditions on the detail.

(1) Measure to see that maximum and minimum dimensions will fit. While the drawing dimensions are optimum, you should modify them when necessary. Indicate:

- (a) Existing wall construction.
- (b) Existing deck construction.
- (c) Existing insulation thickness, if applicable.
- (d) Existing bitumen type.
- (e) If a vapor retarder or underlayment is present.
- (f) If any parts of the existing materials can be left in place, or removed and reused.

(2) Determine if the plumbing connection to the roof drains require attention in the contract.

f. No collection of standard drawings can be universal to cover all situations. Apply a certain amount of judgement when using NRCA/SMACNA details. In some cases you may have to modify NRCA/SMACNA details. You should refer the most difficult details your major command roofing engineer.

g. Below is a table that shows the sheet metal types and corresponding gauges, weights, and thicknesses that can be used for the items listed. Reference standards for the sheet metal types are in the master specification.

Sheet Metal Selection Guide			
AA			
	Galvanized		Lead-Coated
Detail Item	Steel	Copper	Copper
AA			
Counterflashings	24 gauge	16 ounce	16 ounce
Pressure bars	1-1/4x3/16x2"	1-1/4x3/16x2"	1-1/4 x 3/16x2"
Wall coping	24 gauge	16 ounce	16 ounce
Continuous Cleat	20 gauge	20 ounce	20 ounce
Expansion joint curb clip	1/8 x 8"	N/A	N/A
Counterflashing receiver	20 gauge	20 ounce	20 ounce
Gravel stop and fascia	24 gauge	16 ounce	16 ounce
Scupper, conductor head and conductor	24 gauge	16 ounce	16 ounce
Gutter	24 gauge	16 ounce	16 ounce
Cradle support	3/16 x 1"	3/16 x 1"	3/16x1"
Sanitary vent pipe flashing*	24 gauge	16 ounce	16 ounce
Tubular penetration flashing	24 gauge	16 ounce	16 ounce
Pitch Pan	24 gauge	16 ounce	16 ounce
"H" column hood	16 gauge	N/A	N/A
Roof drain gravel stop	N/A	16 ounce	16 ounce

NOTE: The Sheet Metal Selection Guide covers the detail conditions shown in the standard NRCA/SMACNA drawings. If project conditions result in increased sheet metal cross-sectional width, comply with applicable SMACNA gauge, thickness and weight requirements.

AAAAAAAAAA

*4 lb lead and preformed neoprene are also recommended for metal and PVC pipes, respectively.

REFERENCES ON ROOFING SUBJECTS

AIR FORCE MANUALS/REGULATIONS

- AFM 85-3
Paints and Protective Coatings
- AFM 88-3
 - Chapter 1, Load Assumptions for Buildings
 - Chapter 3, Masonry Structural Design for Buildings
 - Chapter 8, Metal Roofing and Siding
 - Chapter 14, Design Criteria for Facilities in Areas Subject to Typhoons and Hurricanes
- AFR 88-15
Criteria and Standards for Air Force Construction
- AFM 91-31
Inspection, Maintenance and Repair of Roofing Systems
- AFR 91-36
Roof Management Program

INDUSTRY MANUALS/PAMPHLETS

- *A Guide To Preparing Built-Up Roofing Specifications
- *Manual of Roof Maintenance and Roof Repair
- *Manufacture, Selection and Application of Asphalt Roofing and Siding Products
 - Asphalt Roofings Manufacturing Association
 - 6288 Montrose Rd, Rockville MD 20852
- *Architectural Sheet Metal Manual
 - Sheet Metal and Air Conditioning Contractors National Association, Inc.
 - 8224 Old Court House Rd, Tysons Corner, Vienna VA 22180
- *Sectional Properties of Corrugated Steel Sheets
 - American Iron and Steel Institute
 - 150 East Forty-Second St, New York NY 10017
- *Aluminum Standards and Data
 - The Aluminum Association
 - 750 Third Av, New York NY 10017
- *Catalog of Publications and Audio Visuals
 - The Roofing Industry Educational Institute
 - 14 Iverness Drive East, Bldg H, Suite 110, Englewood CO 80112-5608
- *The NRCA Roofing and Waterproofing Manual
- *Application Techniques for Glass Fiber Roofing Felts
- *Commercial Industrial and Institutional Roofing Materials Guide
 - The National Roofing Contractor's Association
 - 6250 River Road, Rosemont IL 60018

MAGAZINES

- *Contractors Guide Magazine
6201 Howard St, Niles IL 60648
- *Roofing Industry Educational Institute Newsletter
14 Iverness Drive East Bldg H, Suite 110, Englewood CO
80112-5608
- *"Professional Roofing" Magazine
The National Roofing Contractor's Association
6250 River Road, Rosemont IL 60018
- *"Roofing, Siding, and Insulation" Magazine
- *"Roofing Design" Magazine
Edgell Communications Inc.
7500 Old Oak Blvd, Cleveland OH 44130
- *"Western Roofing, Insulation and Siding" Magazine
27202 Via Burgos, Mission Viejo CA 92691
- *"Roofer" Magazine
D&H Publications, Inc.
10990 Metro Parkway, Fort Myers FL 33912
- *"Exteriors" Magazine
P.O. Box 6319, Duluth MN 55806-9961

TEXT BOOKS

- *Manual of Built-Up Roof Systems (second edition), by C.W. Griffin Jr., P.E., for The American Institute of Architects
McGraw-Hill Book Company
330 West 42nd St, New York NY 10036
- *Roofs--Design, Application, Maintenance--Maxwell Baker (1980)
Multiscience Pub. Co, 1253 McGill College, Suite 111,
Montreal, Quebec Canada H3B 2Y5